Concrete

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Form Construction and Concrete Conveying Methods

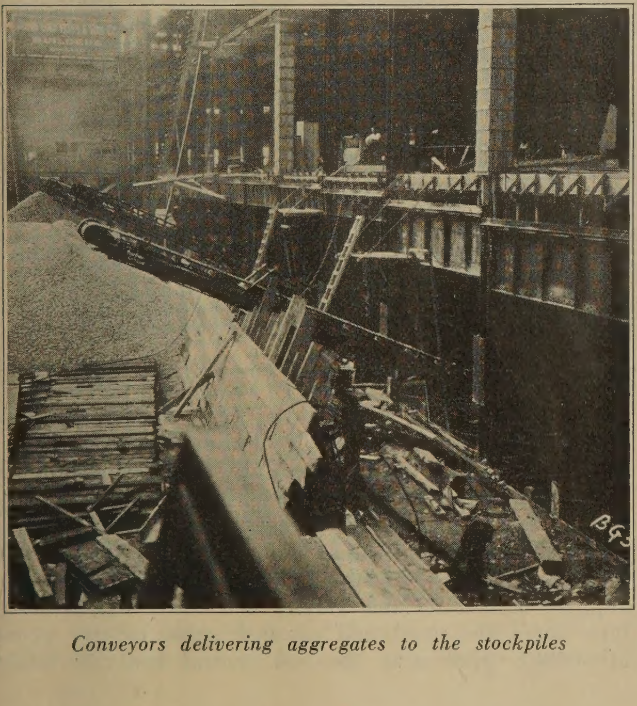
On World's Largest Building

Use of Steel Joists in Form Erection and Belt Conveyors for Distributing Concrete Are Outstanding Features on Construction of Merchandise Mart, Chicago

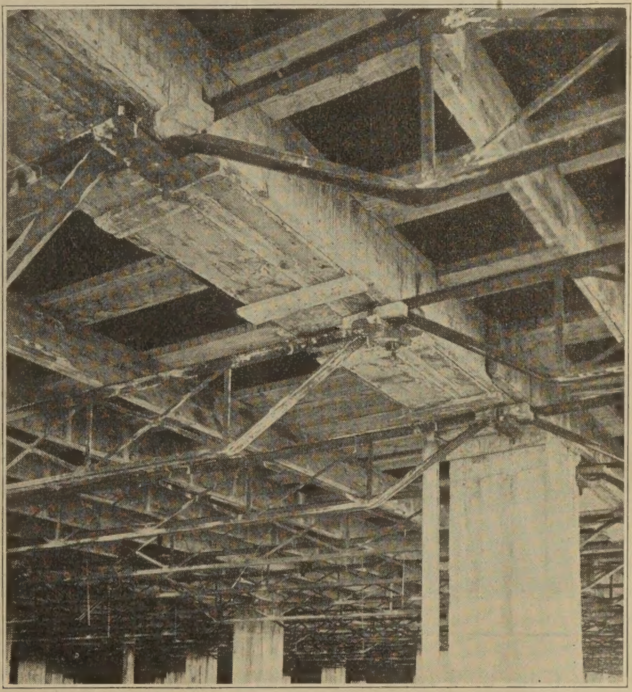
THE use of steel joists to support the form work of floor panels and the use of belt conveyors to distribute concrete from the towers to the place of deposit constitute the two outstanding features in the construction of the Merchandise Mart, an air-rights structure being built in Chicago over the tracks of the Chicago & Northwestern Railway at Wells Street, on the north bank of the Chicago River.

They illustrate the application of some of the newer developments in construction equipment to large scale jobs.

The Merchandise Mart will have a gross floor area of approximately 5,800,000 sq. ft., making it the largest building in the world in point of floor area. The structural frame is concrete-encased structural steel, with floor panels of the reinforced concrete joist and removable pan type. Approximately 190,000 cu. yd. of structural concrete will be used in the structure above the caissons, while the caissons utilized about 46,000 cu. yd. The methods used in building the substructure were described in the October, 1928, issue of CONCRETE.



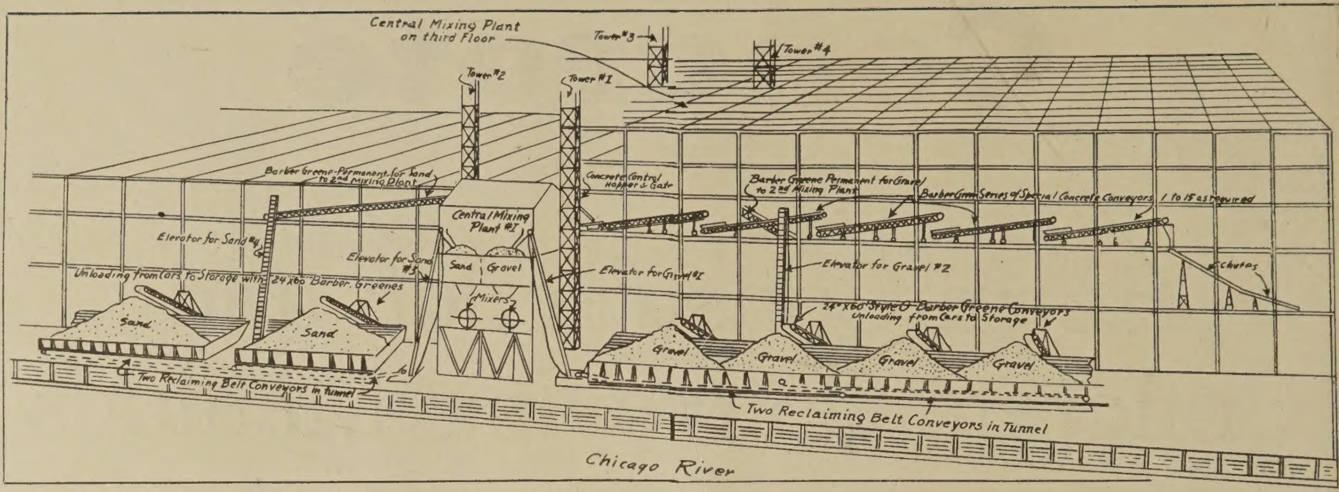
Conveyors delivering aggregates to the stockpiles



General view of form work supported by suspended steel joists

Because of the magnitude of the concrete work involved, the general contractors, John Griffiths and Son Co., planned the work so as to make use of some of the newer developments in equipment and materials and to adapt them to the problems arising on that job.

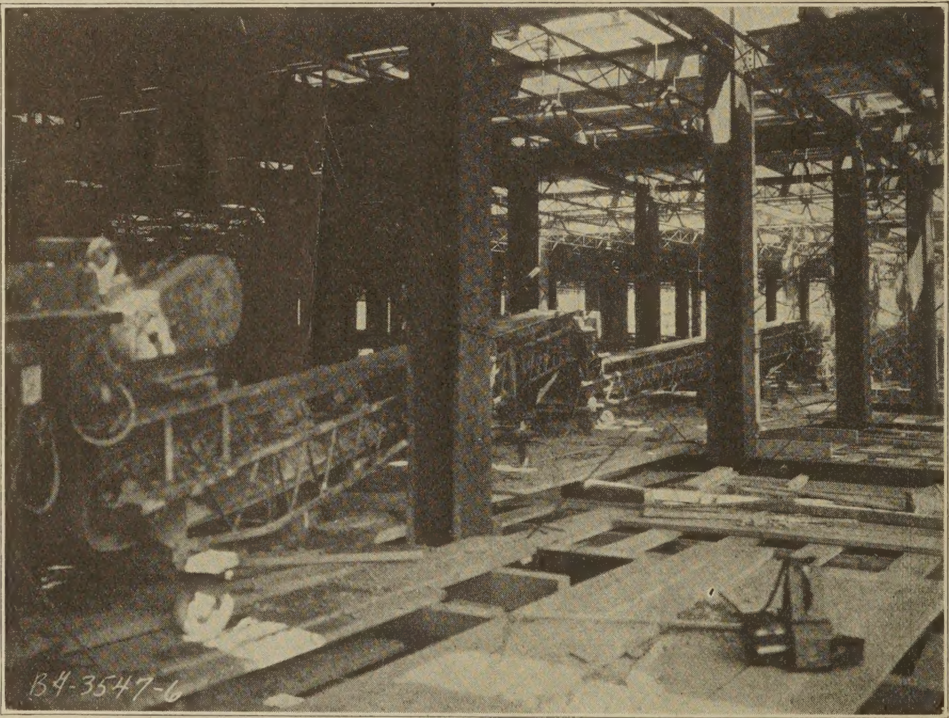
The Merchandise Mart is a building of only medium


Central Mixing Plant on third Floor
Tower #3
Tower #4
Tower #2
Tower #1
Barber Greene-Permanent for Sand to 2nd Mixing Plant
Concrete Control Hopper & Gate
Barber Greene Permanent for Gravel to 2nd Mixing Plant
Barber Greene Series of Special Concrete Conveyors 1 to 15 as required
Central Mixing Plant #1
Elevator for Sand #4
Elevator for Sand #3
Sand
Gravel
Mixers
Elevator for Gravel #1
Elevator for Gravel #2
Chutes
Unloading from Cars to Storage with 24 x 60 Barber Greenes
24" x 60" Style O Barber Greene Conveyors Unloading from Cars to Storage
Sand
Sand
Gravel
Gravel
Gravel
Gravel
Two Reclaiming Belt Conveyors in Tunnel
Two Reclaiming Belt Conveyors in Tunnel
Chicago River

Sketch showing mixing plants and layout for transporting concrete

height (18 stories), but the ground area extends over the equivalent of two city blocks. In ground plan the building is 724 feet long, while the width is 324 feet at one end and 577 feet at the other. The size of the project may be visualized from the fact that 452 caissons were required in the foundation work.

The caissons, extending to an average depth of 90 feet, are of various cross-sections, ranging from diameters of 5 ft. 6 in. to 9 ft. 9 in. These caissons were excavated and concreted in the period between September 1 and December 25, 1928. In spite of the proximity to the Chicago River, all caisson excavations were dry to bedrock. Some hardpan was encountered in each hole, requiring the use of rock hammers.



A series of portable belt conveyors delivering concrete to the forms

Material Delivery

Approximately 60 carloads of material are received on this project daily, half of which are either sand or crushed stone. Because of the presence of the C. & N. W. tracks underneath the structure, it is possible to deliver these cars at any point on the construction site. Full advantage has been taken of this circumstance, and the various materials are delivered at points most conveniently located with respect to further handling.

Cement is received in bulk. At first this material was delivered by boat, but all later delivery is by rail. After being unloaded from the cars, further handling of cement is accomplished by Fuller-Kinyon pumps, a system employing compressed air pressure, which delivers this material to the mixers.

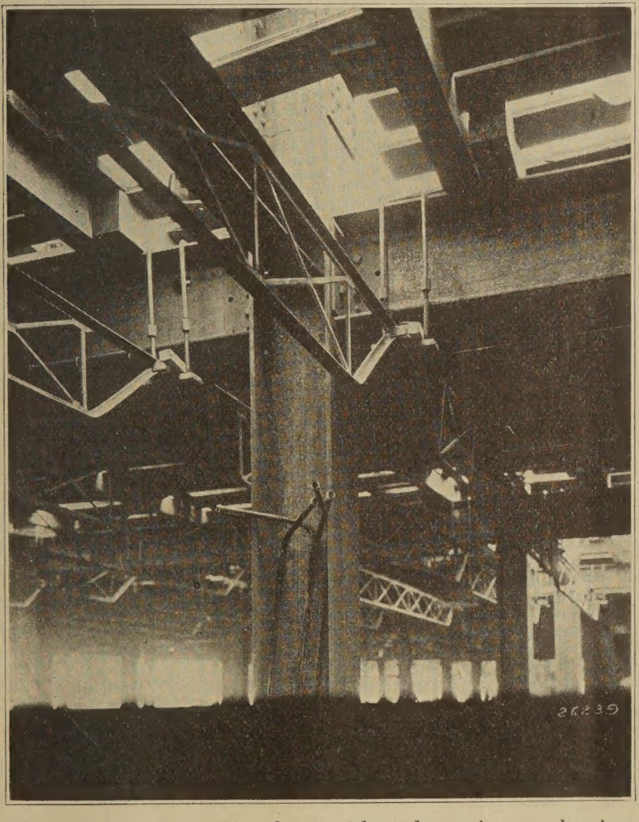
Fine and coarse concrete aggregates are received in hopper-bottom cars, which dump the material into receiving hoppers beneath the tracks. These receiving hoppers deliver the material to belt conveyors, which in turn carry the sand and crushed stone to two groups of storage piles near the two central concrete mixing plants. Four conveyors are required to deliver the crushed stone and two for delivering sand. These six belt conveyors are each 60 ft. long and 24 in. wide, of Barber-Greene manufacture. Each one handles about 5 cars of material daily. The belts are cleated.

From the storage piles the concrete aggregates are delivered to belt conveyors in tunnels underneath the piles, conveyed to the mixers and dumped into material batching bins of Blaw-Knox manufacture.

The two central mixing plants, one located near the center of the building and the other near the middle of the river side, and outside the building, are each equipped with two one-yard mixers of the Koehring type.

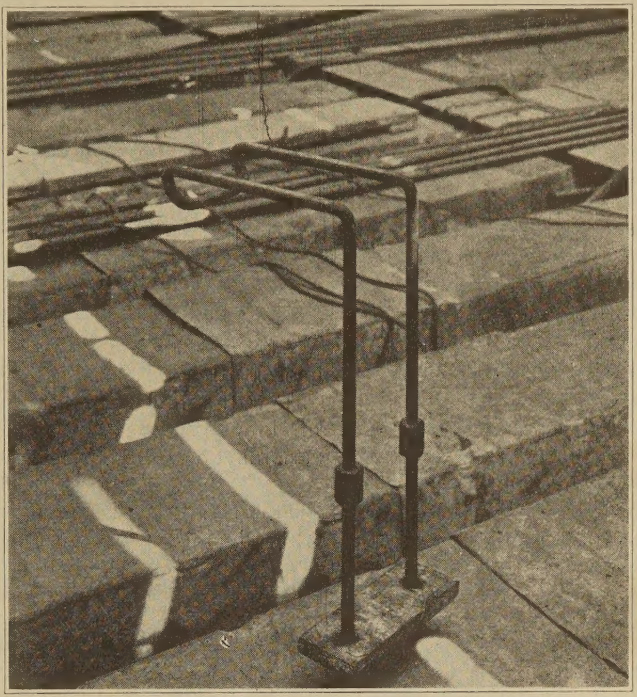
Belt Conveyors Distribute Concrete

Four concrete elevating towers, one for each mixer, are equipped with one-yard buckets which carry the newly mixed concrete to a level two stories above the floor being concreted. It is from this stage forward that the method of distribution of concrete differs from methods usually employed. If the more commonly used method of distribution by buggies had been employed, the construction superintendent would have been compelled to choose between long lines of buggies or a greater number of concrete mixers and elevating towers. Either choice would have resulted in much interference between concreting equipment and gangs and workmen of other trades. Consequently the method of distribution developed resulted not only in eliminating much interference, but it reduced the number of workmen employed.



Steel joist stringers in place, with ends resting on bearing plates bolted to special hangers. Note how the hangers are hooked over top flange of steel girders

The distribution of concrete from the elevating towers is made by means of several series of portable Barber-Greene belt conveyor units, arranged in tandem, on the floor immediately above the floor being concreted. The conveyor units are 40 ft. long and 24 in. wide, of the endless belt type mounted on rubber-tired casters. These units are built in sections, so that odd lengths may be installed where special lengths are necessary. Altogether there are 55 of these large conveyor units on the entire project engaged in conveying aggregates or freshly mixed concrete. Eleven of the units are each 60 ft. long and 44 are each 40 ft. long. An interesting feature about these units is that they were devised and designed by the general contractor's organization, in co-operation with the manufacturer's engineering department.



Separate view of special hanger used to support steel joist stringers

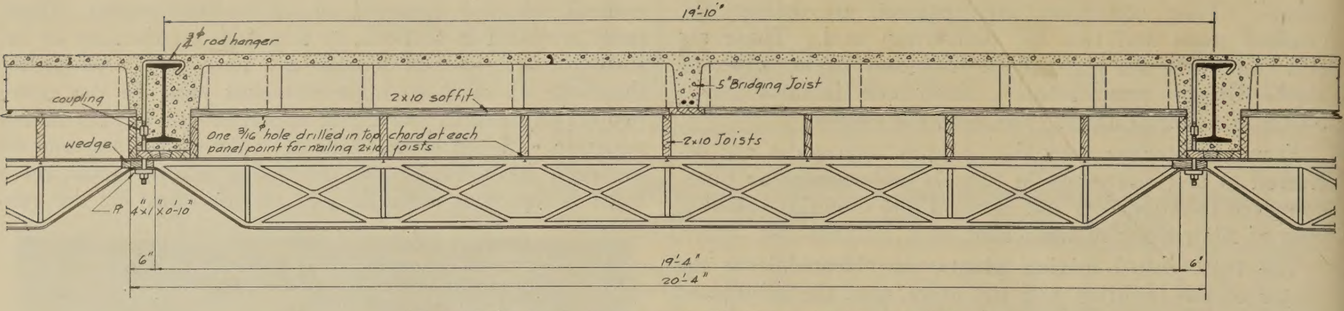
Form Work

The erection and taking down of form work on this project, as stated at the beginning of this article, constituted another of the features of the job. We refer in particular to the use of steel joists of standard manufacture which are used as stringers to support the form work for the floor panels.

The floor construction consists of a one-way system of reinforced concrete joists and removable metal pans, supported on concrete-encased structural steel girders spanning from column to column. The concrete joists are spaced 25 in. center to center. The removable pans are known to the trade as the Ceco Pan-Form. End sections of the pans are flared to increase the cross-sectional area of the concrete joists near their ends.

Instead of following the usual practice of supporting this floor form construction with shored timbers, the general contractor's organization again devised a labor-saving method by utilizing, as the primary support, steel joists suspended from the structural steel girders. The steel joists are partly of Kalman manufacture and partly of the Bates type. The weight of an individual joist is 155 lb., easily handled by two men. For most of the floor panels these supporting steel joists are 20 ft. 4 in. long.

The steel joists, as the illustrations show, are set from 4 to 5 ft. apart and are supported at the ends on special hangers suspended from the structural steel girders. The hangers consist of U-shaped ¾-inch round rods, the top of the U passing over the top flange of the girder and


19'-10"
¾" rod hanger
coupling
wedge
2x10 soffit
5" Bridging Joist
One 3/16" hole drilled in top chord at each panel point for nailing 2x10 joists
2x10 Joists
R 4"x1"x0'-10"
6"
19'-4"
6"
20'-4"
KALMANTRUSS STEEL JOIST USED AS STRINGERS ON MERCHANDISE MART FOR SUPPORTING SLAB AND BEAM FORMS

Steel truss used as stringer for supporting slab and beam forms

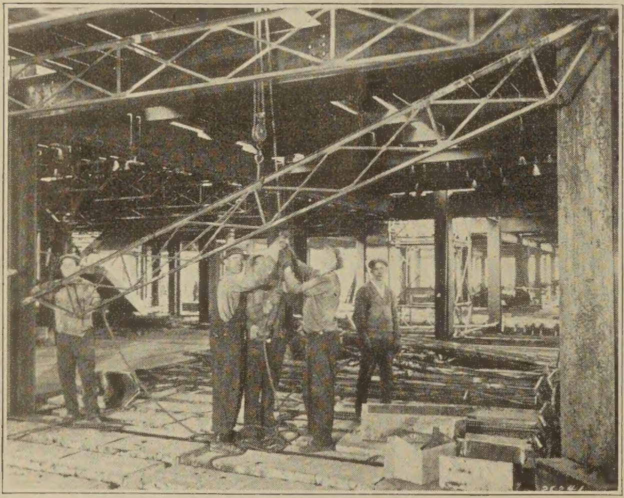
hooking around the far side of the girder flange. One of the illustrations shows these hangers in service, while another illustration shows a complete view of a hanger.

The hanger rods are spliced near the middle with threaded sleeves, to allow removal of the projecting ends, by the simple process of unscrewing them after the forms are stripped from the concrete. The hole remaining in the concrete is covered up when the ceiling is plastered.

The hangers have bearing plates attached near the bottom. The steel joists are hoisted into place by means of pulleys, and the ends of the joists rest on the hanger bearing plates, after which vertical adjustments are made by turning the nuts that hold the plates. Wooden wedges are then driven in alongside the joist ends so as to hold them securely in place.

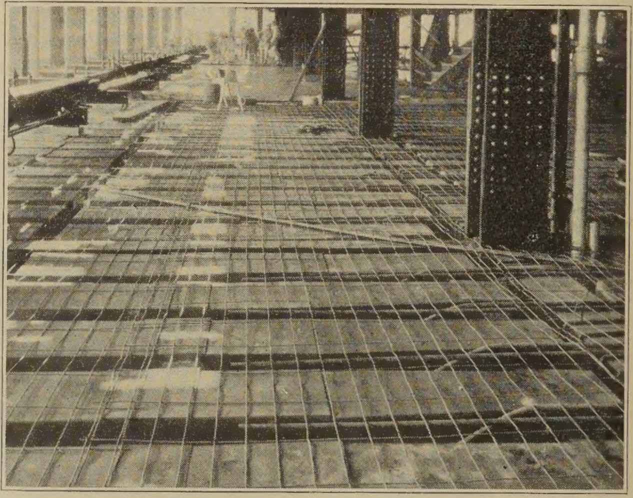
Wooden joists, 2 by 10 in. in nominal size, are then laid flat across the steel joists and used as a temporary working platform.

The next step consists in placing the forms for the concrete encasement of the structural steel girders. The form boards for the bottom of the girders are first slipped into place, being notched to fit around the hangers, and are supported on the steel joist stringers. The girder side forms are then set into position and held in place by light steel strips. Then the 2 by 10 in. wooden joists (thus far used as a temporary working platform) are raised up on edge and nailed to the steel joist stringers by driving nails part way through 3/16 in. holes drilled into the upper flange of the steel joists. Following this step, 2 in. by 10 in. wood soffits for the reinforced concrete joists are nailed down across the wooden joists just described. The ends of the wooden soffits rest on the sides of the girders, thereby holding the 2 by 10 in. wooden joists in an upright position.



Steel joists to support floor panel form work being hoisted into place

The usual practice is to leave the form work in place for two weeks after the floor panel is concreted. The first step in stripping the forms consists in pulling the nails which had been driven into the wooden joists through holes in the upper flange of the steel joists. The wedges at the ends of the steel joists are then knocked out. This loosens the steel joists, which are then removed and used over again at another location. Following this, the hanger bearing plates are removed and the protruding ends of the hanger rods are unscrewed and removed, also for use elsewhere. The remainder of the form work is stripped in the usual manner.



General view of wire mesh reinforcing. Four million sq. ft. of American Steel and Wire Company Electric Weld fabric are being used

Very little cutting of form lumber is done on the job. The greater part of the form lumber as well as other woodwork is done in a separate shop, well equipped with electric power-driven tools.

In reference to the power used, this entire project employs only electric-driven or pneumatic tools and equipment. This applies to the concrete mixers, the cranes, the derricks, the conveyors, and all other equipment.

Graham, Anderson, Probst & White, of Chicago, are the architects of this building. George W. Allen is serving as architect's superintendent. The general contract is held by the John Griffiths & Son Co., with Bruce A. Gordon as superintendent in charge of construction.

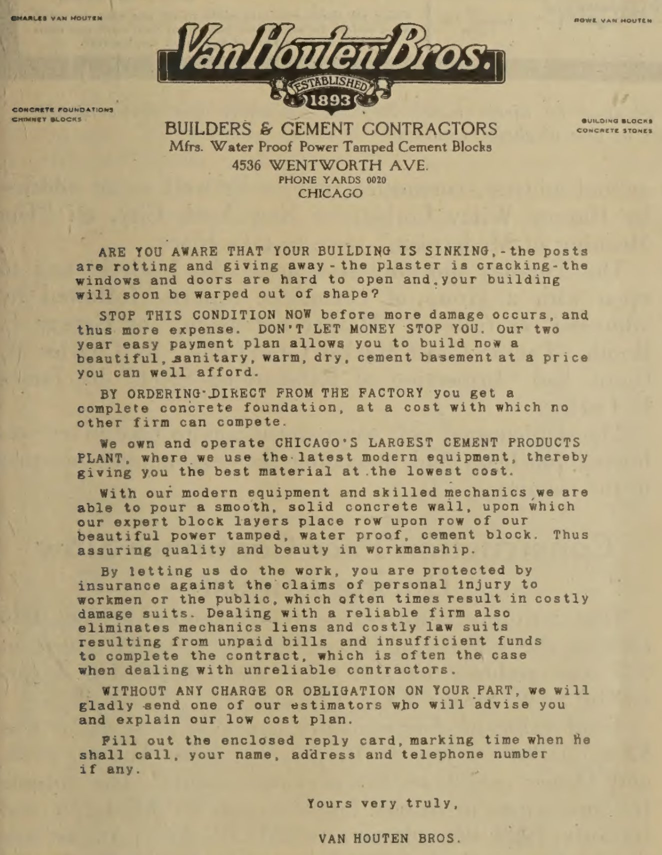
Selling Block Foundations By Mail

Van Houten Bros., Concrete Block Foundation Specialists, Sell Limited Field 100 Per Cent—Make Use of All Approved Methods—Direct Mail System Proves Success

WELL-PLANNED use of direct mail intensely applied backed up by personal selling has paid large dividends to Van Houten Brothers, Chicago. This firm has put the force of direct mail and personal sales to work for it and is still amazed at the results shown. From a one-man firm doing a small business the organization has grown to a firm employing more than 100 men and doing $200,000 worth of business annually. Intensive promotion has been the reason.

Sales Force

The success of the firm's sales plan lies not in its uniqueness, but in its thoroughness. The sales force today is composed of five men who combine the duties of salesman and inspector. As part of the men's work a survey for houses needing new basements and foundations is made. The owner's name is secured and the owner then becomes a prospect for sales work.



CHARLES VAN HOUTEN

ROWE VAN HOUTEN

Van Houten Bros.
ESTABLISHED
1893

CONCRETE FOUNDATIONS
CHIMNEY BLOCKS

BUILDING BLOCKS
CONCRETE STONES

BUILDERS & CEMENT CONTRACTORS
Mfrs. Water Proof Power Tamped Cement Blocks
4536 WENTWORTH AVE.
PHONE YARDS 0020
CHICAGO

ARE YOU AWARE THAT YOUR BUILDING IS SINKING,-the posts are rotting and giving away-the plaster is cracking-the windows and doors are hard to open and,your building will soon be warped out of shape?

STOP THIS CONDITION NOW before more damage occurs, and thus more expense. DON'T LET MONEY STOP YOU. Our two year easy payment plan allows you to build now a beautiful, sanitary, warm, dry, cement basement at a price you can well afford.

BY ORDERING DIRECT FROM THE FACTORY you get a complete concrete foundation, at a cost with which no other firm can compete.

We own and operate CHICAGO'S LARGEST CEMENT PRODUCTS PLANT, where we use the latest modern equipment, thereby giving you the best material at the lowest cost.

With our modern equipment and skilled mechanics we are able to pour a smooth, solid concrete wall, upon which our expert block layers place row upon row of our beautiful power tamped, water proof, cement block. Thus assuring quality and beauty in workmanship.

By letting us do the work, you are protected by insurance against the claims of personal injury to workmen or the public, which often times result in costly damage suits. Dealing with a reliable firm also eliminates mechanics liens and costly law suits resulting from unpaid bills and insufficient funds to complete the contract, which is often the case when dealing with unreliable contractors.

WITHOUT ANY CHARGE OR OBLIGATION ON YOUR PART, we will gladly send one of our estimators who will advise you and explain our low cost plan.

Fill out the enclosed reply card, marking time when he shall call, your name, address and telephone number if any.

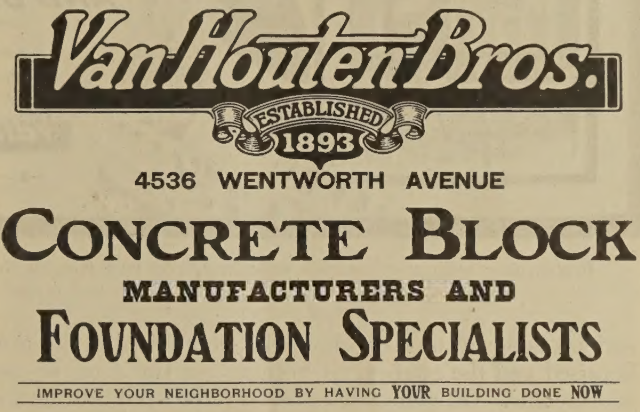
Yours very truly,

VAN HOUTEN BROS.

The type of appeal made to home owners by Van Houten Bros. This is a reproduction of a letter on the first page of a 4-page circular which is shown on the following page

The preliminary selling is done by direct mail. The firm has worked out a series of five illustrated letters which are sent the owner from time to time, the interval between letters varying according to the situation. These letters are not intricate or clever; rather they are designed to appeal to the common sense of the owner through a simple and direct message.

Since the firm began this systematic canvass for prospects, an active list of between 40,000 and 50,000 names has been secured. This list is added to from time to time as prospects become clients.



Van Houten Bros.
ESTABLISHED
1893
4536 WENTWORTH AVENUE
CONCRETE BLOCK
MANUFACTURERS AND
FOUNDATION SPECIALISTS
IMPROVE YOUR NEIGHBORHOOD BY HAVING YOUR BUILDING DONE NOW
CALL YARDS 0020

While Van Houten Bros. are engaged on a project they post this job sign in a conspicuous position

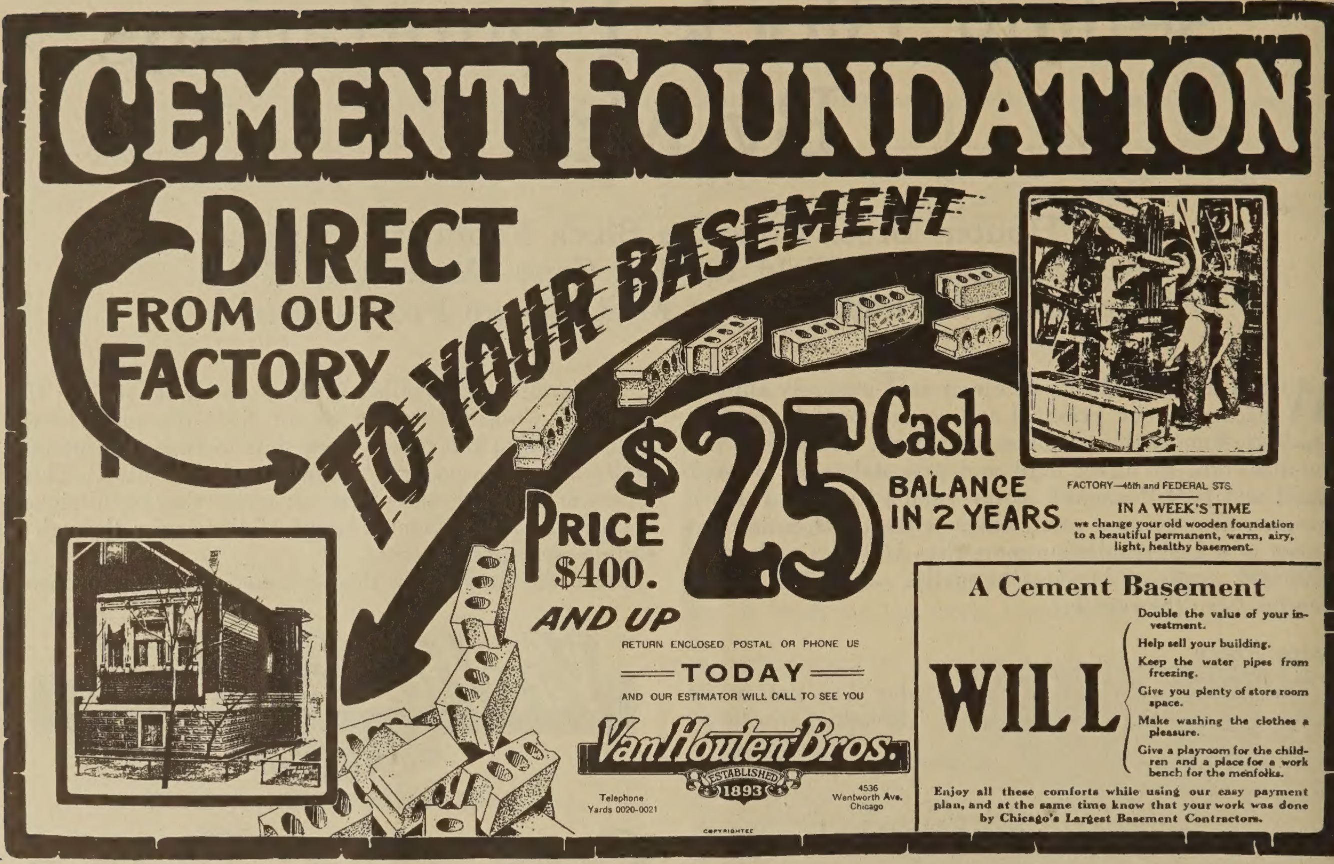
Personal Appeal

The first letter states that a survey of the property has shown a need for the kind of service the firm is equipped to give. The letter shows that the information contained is not mere guesswork, but has been gotten by a personal survey of the property. If no answer is received from the first letter a second is sent and so on until all five have been mailed if necessary. That there is a personal appeal is shown by numerous instances where customers have shown the salesman the first letter sent, sometimes months after its mailing.

As an action reminder, each letter carries a post card which can be mailed to the firm asking a salesman to call. When the card comes in a salesman is assigned and is instructed to call promptly. It is his duty to survey conditions and quote prices on the remodeling job.

Scale of Prices

The firm is a strong believer in uniform quotations and has worked out a set scale of prices based on past experience. It has been found that this established scale has a very noticeable influence on good will. Once a customer realizes that his work is being bid in at exactly the same



CEMENT FOUNDATION

DIRECT FROM OUR FACTORY TO YOUR BASEMENT

PRICE $400. AND UP

$25 Cash

BALANCE IN 2 YEARS

FACTORY—45th and FEDERAL STS.

IN A WEEK'S TIME
we change your old wooden foundation to a beautiful permanent, warm, airy, light, healthy basement.

RETURN ENCLOSED POSTAL OR PHONE US

TODAY

AND OUR ESTIMATOR WILL CALL TO SEE YOU

Van Houten Bros.
ESTABLISHED 1893

Telephone
Yards 0020-0021

4536
Wentworth Ave.
Chicago

COPYRIGHTED

A Cement Basement

WILL
- Double the value of your investment.
- Help sell your building.
- Keep the water pipes from freezing.
- Give you plenty of store room space.
- Make washing the clothes a pleasure.
- Give a playroom for the children and a place for a work bench for the menfolks.

Enjoy all these comforts while using our easy payment plan, and at the same time know that your work was done by Chicago's Largest Basement Contractors.

Preliminary selling of concrete foundations by Van Houten Bros. is done by direct mail. Reproduced above are the contents found on the two inside pages of one of their circulars

scale as other owners are quoted his confidence in the firm is raised and the bugbear of holding out for a cut in cost is overcome. Of course there is a certain flexibility in this scale. It is not possible to find all properties having exactly the same conditions and to evaluate the difficulties in terms of added cost to the firm so that a profit can be made is a part of the salesman's job.

$4,000,000 Output of Concrete Products by Canada in 1928 Is Highest

Manufactures of concrete products in Canada during 1928 were valued at $4,136,955 according to a bulletin issued by the Dominion Bureau of Statistics. This value was the highest ever reported for the industry and was 55 per cent above the total of $2,663,065 reported in 1927.

Ontario with 105 plants and Quebec with 34 together produced more than 90 per cent of the total output in the Dominion. The 151 plants employed capital reported at $4,140,543 and furnished work to an average of 1,262 people throughout the year. Payments for salaries and wages amounted to $1,446,508, materials used cost $1,261,653 and the value added by manufacturing was $2,875,302.

Reinforcing Institute Holds Semi-Annual Sessions

The Concrete Reinforcing Steel Institute, Chicago, is now holding its semi-annual meeting at the Hotel Wawasee, Wawasee, Indiana. The initial event was the meeting of the board of directors, scheduled for Monday morning, September 30th. Regional conferences were to take place in the afternoon, followed by the opening session of the Institute, in the evening. At this time the president's semi-annual address, committee reports, as well as an address by Harvey Wiley Corbett of New York City, on "The Meaning of Modernism" were to take place.

The Tuesday morning session of the Institute was to open with a group of committee reports, followed by addresses, as follows. "Market Extension," by George E. Routh, "Pacific Coast Market Conditions," by Charles M. Gunn, and "Inspection of Reinforcing Steel," by James F. Curley.

The semi-annual golf tournament was to take place following luncheon and preceding the semi-annual banquet in the evening.

Construction Pace Continues Slow During August

That building construction is slackening is definitely seen in the reports of plans filed or permits issued in 577 comparable cities and towns and compiled in a survey by S. W. Straus & Co., Chicago.

Total value of August construction in these cities was $256,720,837—a loss of 18 per cent from August, 1928, and 11 per cent from the previous month. The volume for these cities in August last year was $314,551,218, and for July, 1929, the volume was $287,497,821. August was the fourth consecutive month in which this survey showed losses in building volume for the more than 500 cities.

Study of Subgrades

One of the road-building problems receiving attention at the hands of the American Road Builders Association is that of proper subgrades for future pavements. The association has pointed out that much money can be saved in the road construction of the next decade by the proper preparation of the natural earth foundation.

Concrete-Lined Canals

Built in Large Irrigation Project

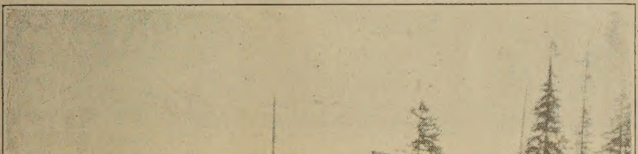
Construction Methods Used in Placing Concrete Lining in 22 Miles of Irrigation Canals on U. S. Reclamation Bureau Job

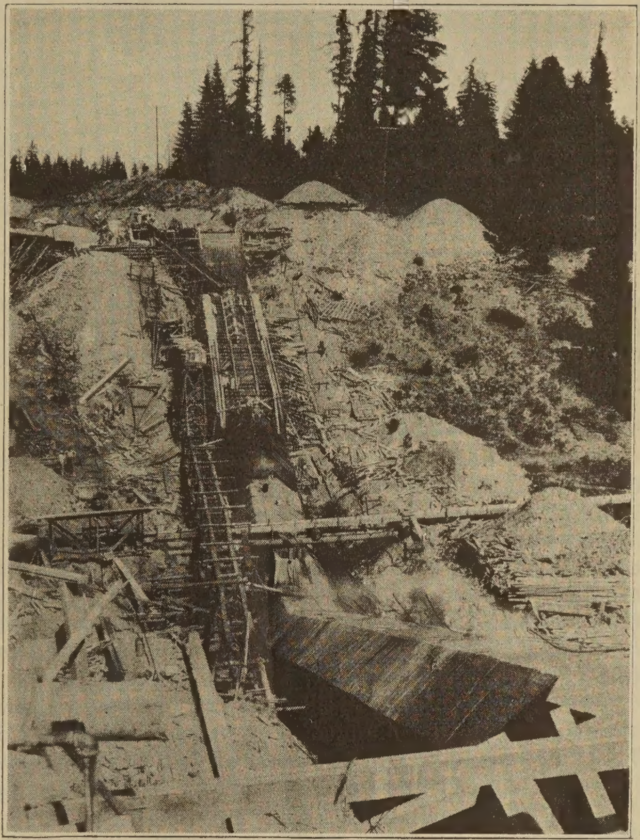
OUT in Kittitas County, Washington, the United States Reclamation Bureau is rapidly carrying on the construction of an irrigation project which for size and interest is outstanding. It includes 22 miles of concrete cured canals, 2 miles of tunnel and 4 miles of siphons.

The works under construction and planned will divert water from the Yakima River, carrying the water supplied from the natural flow of this river and from storage reservoirs at Kachess and Keechelus Lakes through a main and branch canal system totaling about 91 miles and through from 350 to 400 miles of laterals. It was planned that water will be available on portions of the main canal in the crop year of 1929 but the entire project will not be completed for some two or three years later.

The project will provide water for the irrigation of about 72,000 acres of land in an area along the Yakima River near the city of Ellensburg.

In all, there are about 20,000 lineal feet or four miles of siphons, 2.2 miles of tunnels and a considerable length in elevated flumes, and about 22 miles of concrete lined canals. The cost of the work planned and for which Congress is appropriating money is estimated by the contract of December, 1925, to not exceed $9,000,000, exclusive of storage facilities already provided.



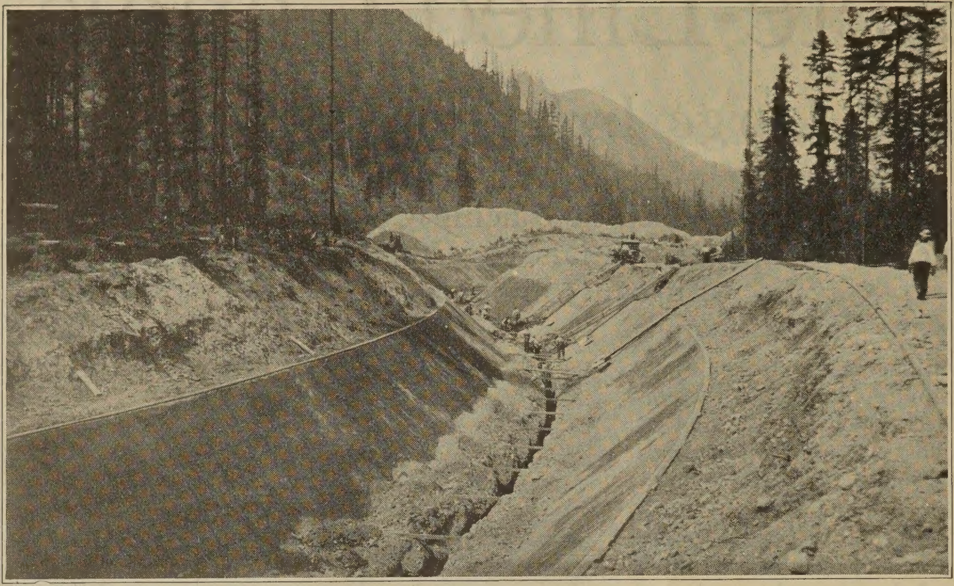


One of the siphons under construction

A steel frame guides a strike-off planer which is drawn up the side of the canal by means of a hand-turned winch

The construction program started in April, 1926. The project is divided into several divisions, the concrete construction in each being as follows:

Division 2, schedule 1—consists of five miles of concrete lined canal using 10,000 cu. yds. of concrete lining at $8.00 a yd. This contract is now complete. Division 2, schedule 2—a five-mile piece of concrete lined canal using 2,800 cu. yds. of concrete lining at $8.00 a yd., now completed. Division 3, schedule 1—a 6-mile section of canal to be concrete lined; contract not yet complete. Division 3, schedule 2—a six-mile main canal section and a ½-mile section of connecting canal using 9,450 cu. yds. of 3-in. concrete lining at $11.50 a yd. This contract is complete. Division 3, schedule 13 consists of two tunnels, both concrete lined. The first tunnel is 952 ft. long while the second is 2,000 ft. long. This contract is completed. The North Branch Canal is not finished. Work on this canal calls for 11 miles of canal with 5,800 cu. yds. of concrete lining at $11.50 a yd. and three tunnels

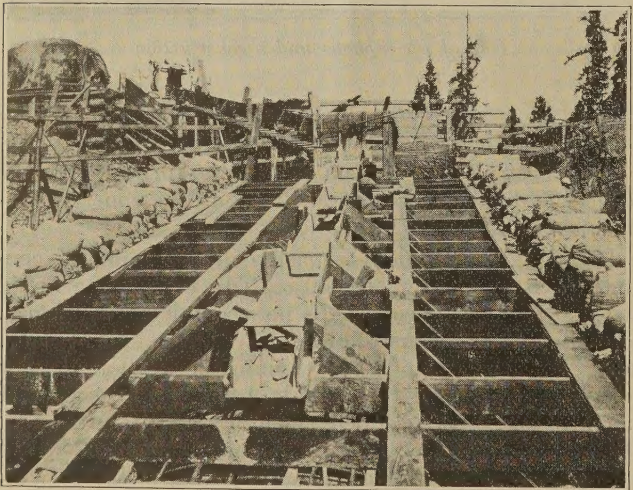


A part of the open canal section showing the general character of the job

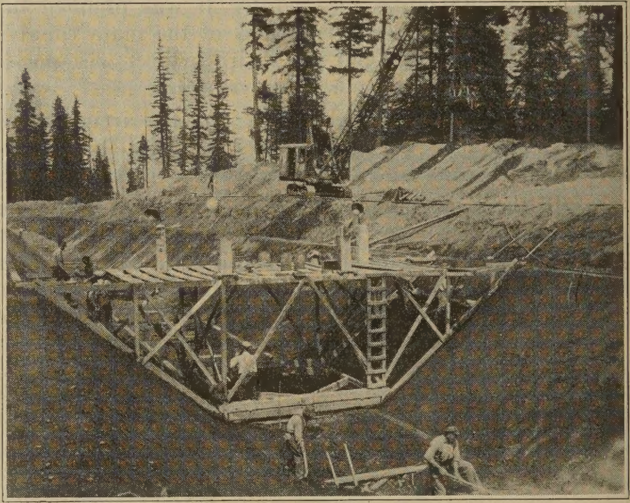
with 7,580 cu. yds. of concrete lining at $10.00 a yd. and four siphons, using 5,500 cu. yds. of concrete and 1,170,000 lbs. of reinforcing. Work has only begun on the South Branch Canal and the Easton Dam.

Construction Methods

In all the lining and structures, concrete of the highest quality is used. The aggregates are proportioned after analyses and grading tests. The maximum size of coarse aggregate is 1 in. for canal lining and 1½ in. for structures. Field mixes are worked out from proportions determined in the dry rodded state. Materials are proportioned by weight and consequently the moisture content is controlled. Impermeability is a necessary factor; therefore concrete having an average compressive strength of 3,500 lbs. per sq. in. is produced. The maximum allowable slump is 3 in., although 1½ in. is generally used. Three per cent by weight of cement of diatomaceous silica is used in the concrete for canal linings. The linings are 3 in. thick and reinforced with ⅜-in. bars spaced 12 in. on centers longitudinally and 24 in. on centers transversely. The top bar at a tie is placed 1¼ in. from the face of the lining.



Concrete for the siphons was chuted down an inclined trough and diverted to the forms



The subgrade is prepared by a platform template that fits the shape of the canal

A variety of equipment is used on the several contracts for excavating and trimming the canals. Fine grading is done from a platform template that fits the shape of the canal. An ingenious wheeled frame platform, which is supported at the base and top of the ditches has been developed for placing concrete on the slopes.

A supported steel frame for each slope guides a strike-off planer which is drawn up the side of the canal by means of a small hand-turned winch. This planer serves to float the concrete into place, and very little hand work is necessary to complete the finishing.

The concrete work throughout, in canals and in structures, is protected after placing. Burlap cover is used after the initial set has taken place, and sprinkling completes the curing.

Contractors for the canals are General Construction Co., Seattle; S. H. Newell & Co., Portland; Barnard Curtis Co., Minneapolis; Derbon Construction Co., Seattle. E. A. Webster & Co., Spokane, is contractor for siphons and wasteways and Rumsey & Jordon are contractors for two tunnels. R. F. Walter is chief engineer for the U. S. Bureau of Reclamation and Walker R. Young is construction engineer, located at Ellensburg, Wash.

Deterioration of Concrete in Hydraulic Structures

A Summary of a Preliminary Report Made by the Swedish Royal Board of Waterfalls Covering Studies on the Causes of Deterioration of Concrete in Hydraulic Structures

By AXEL EKWALL
Chief Engineer, The Royal Board of Waterfalls, Stockholm

AT inspections of hydraulic structures in Sweden, started 10 years ago, leaks and defects in the concrete were discovered. To begin with, these occurred singly and not very extensively, and therefore it was thought sufficient to remedy these defects by local repairs of the damaged sections. Later on, however, increasing deterioration of the main part of the concrete was found in some cases, and gradually it became obvious that its causes could not be due to chance circumstances. Opinions differ very widely as to the causes of the defects; some engineers place the responsibility on the concrete materials, particularly the standard portland cement and the sand; others have found the action of the water surrounding the structure, the methods of construction, the freezing of the concrete during hardening, etc., as the main causes of deterioration. By means of investigations and experiments mentioned below, an effort was made to determine the circumstances causing such damage. This was done partly to ascertain the most suitable methods of repair, and partly to find a way to build new concrete structures avoiding deterioration.

The damage observed, which occurred both in power stations and in canal walls, is generally of similar nature. There has been deterioration in the northern part of this country, where the structures have been exposed to clean melting water from the mountains, as well as in the southern part, where structures have been exposed to more or less impure river water.

One Side Exposed to Water

Without exception it was found that deterioration occurs only in structures *where only one side was exposed to water pressure.* Such water pressure exists not only against any ordinary dam but also against dams having water pressure from both sides if there is a difference in water level, however small. On the other hand, no deterioration whatever could be found in subaqueous concrete structures, which were not exposed to one-sided water pressure, even if these structures had been made with comparatively lean mixtures.

The different characteristics of the water which have been considered to affect the cement are its humus content and its hydrogen ion concentration, the latter as a rule being a consequence of the percentage of carbon dioxide. A series of chemical analyses were made of natural water from different rivers in the vicinity of power stations in order to find the annual variation of the above mentioned qualities and to ascertain if any important difference in water exists at such power stations where concrete defects have been proved and at such where the concrete has been found more resistant. The result of these analyses is the conclusion that variations in the characteristics of the water are comparatively small and that they may hardly be taken as a cause for the defects.

Another investigation, regarding the solubility of portland cement in water has shown that pure and neutral water affects the cement to about the same extent as the natural waters of the Swedish rivers.

Permeability Causes Deterioration

The chemical processes during the hydration of the cement may be substantially characterized by a decomposition of the higher lime silicates into lower silicates and calcium hydroxide. The calcium hydroxide is easily recognized in the microscope as smaller or greater crystallized grains evenly distributed throughout the mass. These crystals of the hydroxide, which are of great benefit for the strength and the watertightness of the concrete, are, however, soluble in water and it is this solubility (about 1 gr. per lit.) that seems to be the main cause of deterioration. The water seeps through pores or cracks in the concrete, dissolves the hydroxide and carries it out to the surface, where it often combines with the carbon dioxide of the air and becomes visible as white efflorescence of carbonate on the concrete surface. Chemical analyses have proved that the hydrated portland cement contains about 13 to 17 per cent of calcium hydroxide. After some time, depending on the porosity of the concrete, the total amount of the hydroxide has been lost. The continued decomposition of the hydrated lime-compounds and of the clinker grains remaining after the hardening may be characterized as a second stage of deterioration. By these processes new quantities of calcium hydroxide are generated, which in turn are carried out of the structure by the percolating water. The dissolving of the free calcium hydroxide and the decomposition of the silicates and other lime-bearing compounds of the cement go on contemporaneously but as the rate of the former process is by far more rapid than the latter one, concrete subject to percolating water will soon be deprived of its total amount of free calcium hydroxide. The decomposition of the lime-bearing compounds, on the other hand, may continue until a complete breakdown of the cement takes place.

It is important to emphasize the difference between concrete exposed to percolating water and concrete protected against this action. In the latter case the calcium hydroxide is entirely beneficial to the structure, as it fills the pores and promotes an increased strength of the concrete, whereas in a porous structure there is always danger that the solubility of the calcium hydroxide will cause complete disintegration. It is therefore, necessary, in constructing hydraulic structures, to select such designs and methods of work which are specially fitted for obtaining originally watertight concrete.

Causes of Porosity

Attention was consequently drawn to the circumstances that governed the porosity of the concrete. First, the humus contents of the sand were investigated. The humus (mixed with iron oxide), appears in sand either as a thin film surrounding the separate grains or as small particles, mixed in the sand. It was proved that the first kind of humus impurity has a considerably greater influence on the porosity of the concrete than the mixed-in particles. An explanation to this phenomenon was reached by means of cores drilled from concrete in different stages of deterioration. A specimen of each core was ground down to transparency corresponding to a thickness of 0.01 to 0.03 mm. and studied under the microscope. In a "slide" of this kind, taken from concrete cured for two months, the humus film is clearly visible as a dark brown border around the separate grains and surrounding this there is an empty space separating the cement from the humus film, indicating the tendency to form pores, which facilitate the percolation of water. Slides taken three months later from the same concrete, when it had been exposed to one-sided water pressure of about 0.4 kg. per sq. cm., confirm quite evidently an increased porosity as well as a continued production of calcium hydroxide.

In this connection a thorough study on the composition of the portland cement has been made, based particularly on earlier research work in Sweden, Germany and the U. S. A. Some rather far-reaching conclusions have been drawn concerning the course of the setting of concrete and the causes, in certain circumstances, of the changes occurring. On the strength of these investigations, it seems apparent that if the concrete is manufactured in such a way as to avoid water leakage, there is no ground for the supposition that the portland cement, at least under normal circumstances, could not be regarded as a sufficiently durable material for hydraulic structures.

The investigations have been supplemented by separate chemical analyses concerning the contents of calcium hydrate and hydrosilicate in the hydrated portland cement, and by investigations concerning the solubility of portland cement in water. Furthermore, an investigation was made on the chemical influence of different admixtures to the cement and the water-resistance of cement mixed with these substances.

In order to find the watertightness of concrete manufactured with different kinds of cement and natural sands with different mixtures, quantities of water, etc., an extensive series of tests was started in 1926, covering longer periods of time.

During the progress of the work, these investigations have gradually been extended and now comprise the effect of various admixtures, viz., lime, trass, potstone powder, slate powder and calcium chloride.

Conclusions

The following is a short resumé of the preliminary observations arrived at.

Clean sand, mixture 1:12, gives very porous concrete. Even a mixture of 1:7 is unsatisfactory from the point of view of watertightness. Really watertight concrete was not obtained with a leaner mixture than 1:4½, and even then only when the quantity of water was correctly adjusted.

Sand with a low humus percentage may, under very favorable conditions, in a 1:4½ mixture, give a useful concrete, from the point of view of watertightness.

Sand with a high humus percentage mixed with clean sand assumed the same qualities in regard to watertightness as the natural, unmixed sand, even though this latter had a somewhat lower humus percentage than the mean percentage of the mixed sand.

Sand with a high humus percentage makes very porous concrete, even in a mixture of 1:4½.

Concrete made with sand containing iron pyrites has not shown any perceptible leakage, either in mixture 1:4½ or 1:7.

Sand containing clay and limestone seems to give a concrete of at least equal qualities to that obtained by clean sand in regard to the watertightness.

High-strength portland cement does not seem preferable to ordinary portland cement from the point of view of watertightness.

A percentage of 3 per cent magnetic pyrites or 2 per cent mica did not affect the watertightness.

Admixtures, such as slate powder, potstone powder and trass used as substitutes for 25 per cent of the cement, do not seem to bring about any noticeable improvement in the watertightness. An admixture of calcium hydrate substituting 10 per cent of the cement, on the other hand, has proven beneficial.

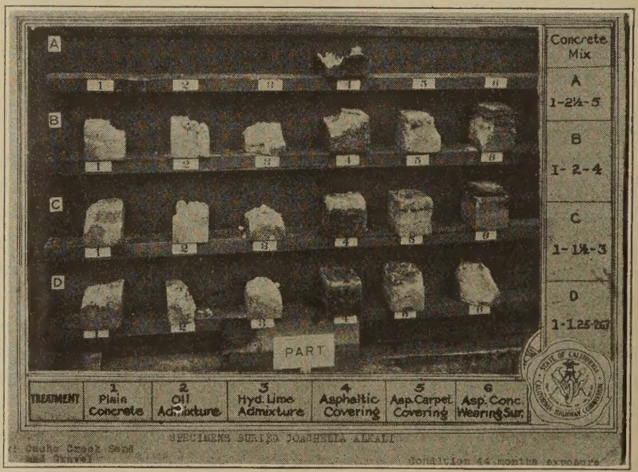
An admixture of 5 per cent calcium chloride seems to have given a watertight concrete, although a comparatively large quantity of water was required to obtain plasticity at these tests.

With clean sand containing a large amount of fine particles—more than 50 per cent less than 0.5 mm.—a watertight concrete was obtained, provided the mixture was not leaner than 1:4½ and that the quantity of water was well adjusted.

California Highway Tests Illustrate Effect of Alkali

The accompanying illustration shows specimens used in tests conducted by the California Highway Research Laboratory to illustrate the effect of alkali on pavement. Cubes of concrete were buried for a period of forty-four months in a sample of alkali soil secured along the highway in one of the desert sections of the state.

A study of the condition of test blocks of concrete after remaining in samples of alkaline soil for forty-four months resulted in the following conclusions:



(A) Asphaltic paint coats or surfaces provide protection to concrete subjected to action of alkali;

(B) Concrete, rich in cement and relatively dense, resists action of alkali better than more porous concretes;

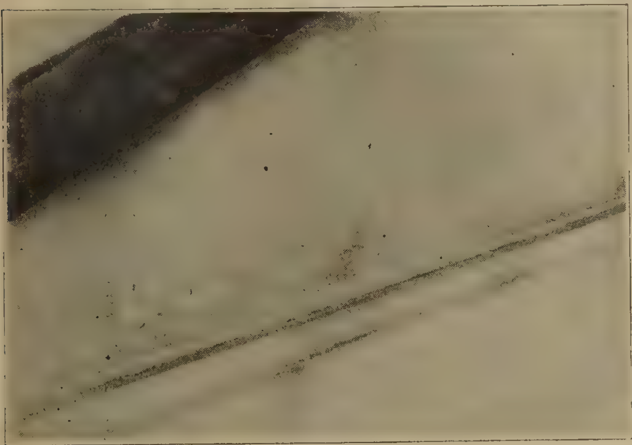
(C) Necessity for insulating against alkali was clearly demonstrated as many of the experimental blocks, subjected to intense action, were entirely destroyed.

Cast Stone and Stucco Provide Uniform Exterior for School

Cast Stone and Portland Cement Stucco Used in Modernizing and Enlarging School Building at Bartow, Fla. —Stucco Overcoating Duplicates Color and Texture of Cast Stone in New Addition

WHEN the school board of Bartow, Florida, decided to improve and enlarge the local elementary school building, a rather old brick structure, the members of the board were faced with the problem of modernizing the old building and choosing a material for the new addition which would produce a uniform exterior appearance. Inasmuch as the old brick building was timeworn and rather shabby in appearance, it would have been difficult and expensive to attempt modernization of the original walls. Likewise, it would have been hard to match the new walls of the addition with the old, but sturdy, walls of the original structure.

Close-up of cast stone work. The old building before overcoating was started is shown in the background



Detail construction view of the schoolroom chalk rail of cast stone

Cast Stone Aggregate Used in Stucco

The decision to use cast stone for the addition presented the problem of renovating the exterior walls of the old building in such a manner as to duplicate the cast stone insofar as color and texture were concerned. This question was answered when it was decided to utilize portland cement stucco in overcoating the old brick walls. To guarantee that the stucco would duplicate the cast stone in color and texture, the same aggregate—limestone screenings—was used in manufacturing the stucco and the cast stone.

The Anchor Stone Company of Tampa, Florida, received the contract for furnishing the stone. Their specifications for the particular cast stone selected were used by the builder, Paul H. Smith of Haines City, Florida, in determining proper proportions for the stucco overcoat to be used on the old building. To insure the closest possible co-operation between the stone manufacturer and the builder, a branch plant of the Anchor Stone Company was established at the site of the new addition. The construction of the new portion of the building was carried on at the same time the stucco overcoating work progressed. Manufacture of the cast stone was started well in advance of the building construction, so that well-cured material was available when needed on the job.

Electric tool being used to produce dummy mortar joints in surface of portland cement stucco, applied to the remodeled Florida school structure

Cast Stone Interior

In view of the fact that it was desired to have a cast stone interior finish as well as exterior facing of the same material, the walls of the addition were built of solid cast stone. By using this method of construction, once a cast stone unit was in place the interior finish as well as the exterior was practically completed. Cleaning and pointing of mortar joints were the only remaining operations required.

Cast stone was used for bearing walls, partition walls, sills, lintels, trim, ornamental work and even for drinking fountains and chalk rails, the latter being built under the blackboards in the school rooms. In fact, cast stone was used wherever possible in the new portion of the building. In building the walls, hollow units were used to reduce the dead load and also to facilitate handling. The cast stone was white in color with the aggregate faintly exposed in the surface. This texture was produced by machine rubbing.

Applying Stucco

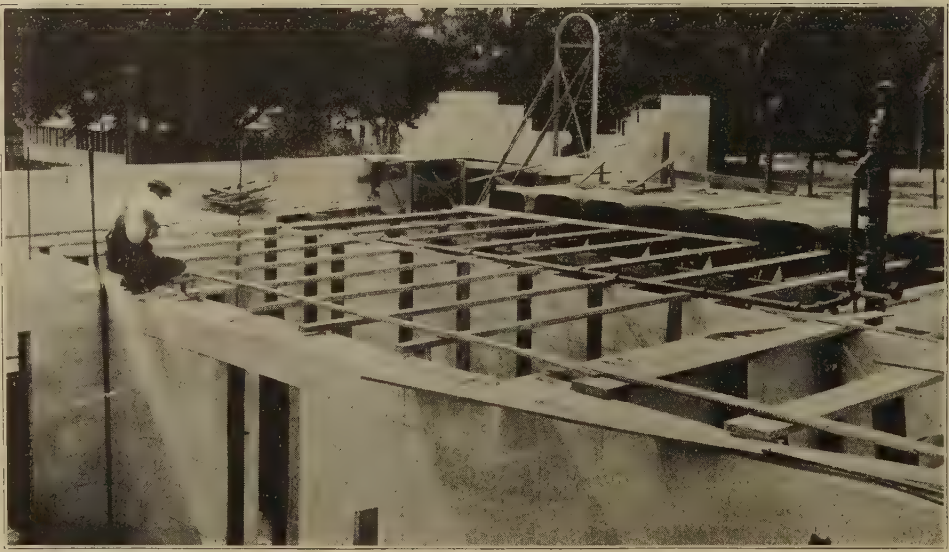
Before applying the portland cement stucco on the old part of the building the surface of the brick walls was roughened thoroughly to insure good mechanical key. The walls were also cleaned to remove oil, dust, dirt, soot or any other material that could possibly interfere with satisfactory bond. The total thickness of the stucco overcoat was ¾ in., the final coat being floated to an even surface and allowed to cure before final finishing. As previously stated, the same aggregate was used in the stucco mixture as was used in the cast stone. This consisted entirely of limestone screenings and portland cement.

Stucco Imitates Cast Stone

When the stucco had hardened dummy joints were cut into the surface to duplicate the appearance of the cast stone walls. The horizontal and vertical joints of the cast stone construction were reproduced very accurately with respect to both thickness and depth. An electric tool was used for this purpose. In order to expose the aggregate in the stucco surface sufficiently to match the cast stone, the stucco was rubbed, an automatic tool being used for this purpose.

Reinforced concrete floors of the ribbed type were used in the new portion of the school, making it entirely firesafe.

E. R. James was the architect for the new addition of the school and was instrumental in carrying out the modernization work.



Building open centering and form work for reinforced concrete floor

EDITORIAL

Modern Building Codes

MANY concrete designers are held down to low working stresses by local building codes. Political inertia makes it impossible for them to take advantage of the newer developments in concrete control by which strengths far in advance of those specified by the code may be secured.

As the costs of labor and materials increase it is more than ever necessary to take advantage of the design economies made possible by the now thoroughly established principles of designing mixes for definite strengths. In fairness to the owners themselves and because of the desire to secure structures of known quality, the old building codes should be revised. They benefit no one and they hold back progress aimed at the very requirements they are designed to enforce.

Much has been done to untangle the knotty problem of absurd variations in individual building codes. State and regional codes have been adopted that take into account the progress made in concrete design and concrete construction methods. The trend is definitely toward greater uniformity and toward codes incorporating the higher working stresses that have been demonstrated as practical.

Yet, by far the greatest number of cities are still paying the penalty of operating under obsolete codes. Year after year the builders in those cities are paying their tax on unprogressiveness. Many of the advantages that modern research in concrete has developed are not for them.

All forward looking contractors and engineers are vitally interested in the building codes of the communities in which they operate. They will find it very definitely to their advantage to support aggressively any movements that aim at code modernization.

Progress in Cast Stone

THERE can be no doubt that, in spite of the struggles of individual manufacturers, the cast stone industry is moving forward steadily, surely and consistently. Though it is much younger as an industry than the concrete block industry, it has taken steps and arrived at a degree of co-operative effort that the block manufacturers have never been able to attain.

No more constructive step could have been taken than the organization of the Cast Stone Institute and the adoption by this body of standard specifications and definitions. Such a step was the first requisite for securing the respect and the co-operation of the architect. Even though the architect may be convinced that in cast stone he has a material of an infinite range of color and design, he will still hesitate to use it unless he is convinced that the structural qualities of the material are all that he desires or expects.

The Cast Stone Institute has accomplished much. Yet, as in all other industries, there are manufacturers who do not subscribe to the high ideals held by the Institute members. A few jobs of inferior workmanship almost overcome the constructive work done by the far-sighted group who look toward the ultimate good of the industry.

Cast stone can be made to meet every requirement of beauty and durability. Architects can confidently use it when it is made by manufacturers who subscribe to the principles outlined by the members of the Cast Stone Institute.

Beauty in Concrete

CONCRETE has long been appreciated as a dependable, all-around, useful structural material. Architects have used it because of its substantial qualities—its dependability and strength. Perhaps that is why so few architects have learned to appreciate its artistic possibilities.

Yet there has never been a material that combined with its structural qualities such a range of decorative possibilities as does concrete. Builders are beginning to realize that in concrete they have a unique material—one that may be cast into forms to provide in one operation both the structural and decorative elements.

The last few years has seen a limited, but steadily growing, appreciation of the beauty of the exposed concrete wall. Developments in form details, the use of plaster molds, and methods of treating concrete surfaces either by exposing the aggregate or by colored coverings have indicated to some extent the decorative possibilities of monolithic concrete. Both for interior and exterior surfaces, treatments and construction methods have been developed that produce monolithic concrete surfaces of outstanding beauty. And when the structural unit of the building is designed to provide the facing also, the resulting savings in veneer and decoration are evident.

Concrete offers a challenge—and an opportunity—to the architect who uses it as a distinctive building material, sought for its own peculiar qualities, and treated frankly.

P. G. RILEY
President

P. G. RILEY
GENERAL CONTRACTOR

~~701 Temple Street Bustown, N. Y.~~

T. G. McGOVERN
General Supt.

Los Angeles

Dear Mac:

John Brundage and I met at the club for dinner, or rather lunch, at noon yesterday, and through force of habit went into the washroom to clean up, though no grime of honest toil was in evidence anywhere upon our persons.

We heard loud sputterings and there was John Murray cleaning up in the manner learned in construction camps far away from modern plumbing and mumbling to himself as from force of habit. He felt around for the old-fashioned roller towel and we heard something which sounded like, "Damn the guy who builds mixers that won't mix! Somebody give me a towel."

John Brundage said, "Well, John, this sounds like old times. What's wrong with you now?"

John Murray comes out of the towel and exclaims, "Hello, you two has-beens. It's a good thing you didn't build that mixer I was cussing, John. Wait a minute and I'll let you two millionaires buy me some food."

We managed to get some corned beef and cabbage ordered, and then I said, "Well, Murray, why the grouch on mixer manufacturers?"

"Oh, damn it all, they have to take tests every so often on that Given school job and they make me hold the stuff in that mixer out there two minutes because it won't turn out uniform concrete in less time than that."

Then John Brundage said, "Well, Murray, being as how I am as you say—a has-been mixer manufacturer—I'll tell you something you should know. The trouble with you contractors is you don't take enough time in choosing your equipment. Now, I'll bet you never thought of studying the mixer drums of concrete mixers. To you a mixing drum is just one of those things all mixers have.

"When uniformity of concrete, speeded charge and discharge, and speeded mixing, as well as the life of the mixer, all depend upon the size and speed of the drum, the material it is made of, the kind of tracks on it, the quantity, quality, design and number of blades and buckets inside the drum, the location, width, depth, pitch, the quality of the discharge chute, size of the drum openings, still, to the average contractor, it is just a drum. You listen to the songs the salesmen sing, but do you find out for yourself the whereofs and wherefors and so forth of the mixing drum?"

"Hell, no," said John Murray; "one would naturally think the mixer manufacturer would know how to design a mixer drum, and I'll bet every one of them would admit their mixing drum was the only one that was right, if I asked them."

"And so," answered John Brundage, "you choose a mixer as you marry a wife, 'for better or for worse, until death do us part.' Just because it's nice-looking and somebody told you that you could live more economically with it than without it, and without knowing whether it has chronic constipation on account of inadequate size of drum openings, improper design of discharge chute, speed of drum, design and number of discharge buckets, fallen arches on account of improper drum tracks and rollers, chronic indigestion on account of wrong mixing action, anemia on account of short-cuts in manufacture, and kidney trouble because of improper design of water tank, I'll tell you, John Murray, companionate marriage is the only thing when it comes to a concrete mixer, or at least a long and careful courtship."

"Gosh, I guess you're right. I'm a working man and need food," was Murray's comeback.

Sincerely,

PG

P. G. Riley is a former contractor spending his days of retirement under California's sunny skies. Mentally, however, he is almost as much "in the game" as he ever was.

Perhaps his greatest pleasure is in keeping touch with his superintendent, Tom McGovern, and, off and on, his secretary, Anna Ryan. His being away from the scene of activity has given P. G. some new viewpoints and he manages, in his letters, to convey to the young folks some of the ideas in the back of his head. One of the bits of advice he has already given "Mac" concerned the wisdom of investigating operating performance when buying equipment. At another time he told Mac of the "catch" in the seemingly attractive trade-in offer. There's a lesson, too, he said recently, in not letting old, inefficient equipment eat up the profits.

In another recent letter "P. G." passed on to Mac a little incident he had heard about, to the effect that horse trading tactics in equipment buying are not the best way of doing business.

Concrete Floor Finishes

Methods for Developing Floor Finishes and Laying Floor Coverings—Information on Concrete and Ceramic Tile, Terrazzo, Art Marble, Slate, Linoleum, Rubber, Cork, Wood Flooring and Surface Treatment of Concrete

Editor's Note: To supplement information given in the July, August and September issues on how to build reinforced concrete floors of the three popular types for residences or small buildings, this article deals with the popular methods of surface finish and treatment. These practical suggestions are intended to help the builder provide any type of surface desired by architects or home owners.

A WIDE variety of floor coverings and finishes permits treatment of concrete residence floors to suit the whims or tastes of practically all architects or home owners. There are really four general groups into which concrete floor finish can be classified—surface treatment, hard surfaces, resilient surfaces and wood surfaces.

Surface Treatment

Surface treatment of concrete residence floors involves several processes including the use of mineral pigments, stains and paints to develop color. These treatments may be applied directly to the structural concrete slab, troweled smooth, or to concrete floor toppings.

Troweled Concrete Floor Finish

Smoothness is one of the first essentials of a concrete residence floor finish. The most common and economical method for obtaining a smooth concrete surface is steel troweling.

Troweling, a very important operation, deserves full consideration. Excessive troweling before the concrete stiffens is to be guarded against. Likewise, sloppy consistencies are to be avoided. An excessively wet mix cannot be troweled without large quantities of fine material being brought to the surface, which will later cause formation of a soft skin or film that will dust. Clay, silt, loam or dust should not be permitted in the topping under any circumstance.

After the concrete has stiffened sufficiently steel troweling will improve the density of the wearing surface. This final troweling compacts the concrete and provides a tight, dense surface.

All efforts must be made (1) to place the finish with a low water-cement ratio and yet retain workability; (2) to use clean aggregates; and (3) to delay final steel troweling as long as possible and yet be able to produce the proper finish.

Recommendations for Floor Topping

Good concrete floor finish should be level and thoroughly bonded to the structural slab. Topping material composed of 1 sack of portland cement, 1½ cu. ft. of torpedo sand and 2 cu. ft. of pea gravel or crushed stone (¼- to ⅜-in.) is satisfactory. Sand containing more than 10 per cent of material passing a 50-mesh sieve should not be used for floor finish. Mixes requiring the least amount of water to obtain a workable concrete produce the most satisfactory topping.

Curing is just as important as troweling or the amount of mixing water, in its influence on the quality of the concrete. Concrete floor finish must be kept thoroughly and continuously wet during the first 10 days after installation. Ponding or sprinkling and the use of damp sand, wet sawdust or wet burlap sacks are some of the curing methods which are most commonly used.

Showing a completed concrete floor that has been marked off

Use of Integral Pigment

This type of color finish involves the use of a topping colored with good mineral pigments. If colored cement is not available, it is best to mix the mineral color pigment with the cement in ball or tube mills before sending the material on the job. This will help to maintain a uniformly colored finish. The color of the aggregate shall harmonize as nearly as possible with the color of the pigment used. Only first quality mineral colors which are not affected by light or lime are recommended. Approximate quantities of color pigments for use in concrete floor toppings are given in the accompanying table. However, test samples should be made to determine the exact quantities required for the desired color and shade. These should be proportioned, mixed and cured just as will be done on the job.

The recommended mix for colored floor topping is 1 part portland cement to 2 parts clean sand passing a ⅛-in. screen, and the mineral color pigment. Colored cement and aggregate should be dry-mixed thoroughly. Then add just enough water to obtain a plastic, quaky mix that holds together well. Under no circumstances should the mix be watery or soupy. Thorough mixing is absolutely essential.

TABLE OF COLORS TO BE USED IN CONCRETE FLOOR FINISH

COLOR DESIRED	Commercial Names of Colors for Use in Cement	Pounds of color required per sack of cement to secure Light Shade	Med. Shade
Grays, blue-black and black	Germantown lampblack* or	½	1
	Carbon black* or	½	1
	Black oxide of manganese* or	1	2
	Mineral black*	1	2
Blue shade	Ultramarine blue	5	9
Brownish-red to dull brick red	Red oxide of iron	5	9
Brick red to vermilion	Mineral turkey red	5	9
Red sandstone to purplish-red	Indian red	5	9
Brown to reddish-brown	Metallic brown (oxide)	5	9
Buff, colonial tint and yellow	Yellow ochre or	5	9
	Yellow oxide	2	4
Green shade	Chromium oxide or	5	9
	Greenish blue ultramarine	6	–

*Only first quality lampblack should be used. Carbon black is light and requires very thorough mixing. Black oxide or mineral black is probably most advantageous for general use. For black use 11 lbs. oxide per sack of cement.

Where color is not needed all the way through the topping, or where lower cost is important, the finish may be placed in two layers. The bottom layer of the topping, without color, is placed to within ¼ in. of the finish floor thickness and struck off level. The colored finish is then placed immediately. Early troweling should be limited to a minimum and the final troweling delayed as long as possible and yet be able to produce the proper finish. Variations in color due to trowel shading are to be avoided. Experienced finishers who are familiar with color work should be employed to do the finishing if possible.

In residential floor construction the colored finish usually is applied to a structural slab already hardened. In this case the structural slab should be left rough. Before applying the topping, the concrete should be cleaned, dampened, and just before placing the new concrete the old surface should be painted with cement and water mixed to the consistency of thick cream. A top finish of not less than ¾ in. is used, whether it is placed in two layers or one.

As soon as the surface has hardened sufficiently to prevent injury, the finish shall be protected against staining and other possible injury by first covering with paper and then with a 2-inch layer of sawdust or shavings. None of these coverings shall contain any material that will stain the floor finish. The covering is kept wet for 10 days, and shall not be removed until all trades have completed their work. When the finish is clean and dry, it usually is waxed with any standard floor wax. The wax shall be applied evenly and preferably rubbed with a power-operated polishing machine. Oil or polish can be used instead of wax, if desired, for finishing.

Factory-mixed floor toppings, consisting of portland cement, mineral color pigment and the required aggregate, are recommended when procured from reliable manufacturers. These require only the addition of water and thorough mixing and careful placing on the job.

Inorganic Staining Process

Staining concrete with inorganic dyes produces a mottled, beautifully mellow effect. Staining is done after the concrete topping has dried out. The surface must be free from oil, plaster, lime or other stains. Directions of inorganic stain manufacturers for preparing a concrete floor topping or surface for the staining process must be closely followed.

Painting Concrete Floors

Before painting a concrete floor it is necessary to remove all dirt and to neutralize the surface by brushing on a solution of zinc sulphate. The solution, 4 pounds of zinc sulphate dissolved in 1 gallon of clean water, may be applied with paint brush, mop or squeegee after the concrete has become thoroughly dry. Before applying paint the surface should be allowed to dry for at least 48 hours and then be brushed to remove the zinc sulphate crystals and dust.

The work is similar to painting the ordinary wood surface. The results of tests show that paints composed of pure linseed oil or of hard-drying varnish, in which are suspended abrasion-resisting pigments of the desired color, give excellent results. The first coat should be diluted with turpentine or other suitable thinner to get good penetration. The second and third coats are applied without being diluted.

Concrete floor tile on a concrete floor, as used in a Philadelphia residence

Hard Surfaces

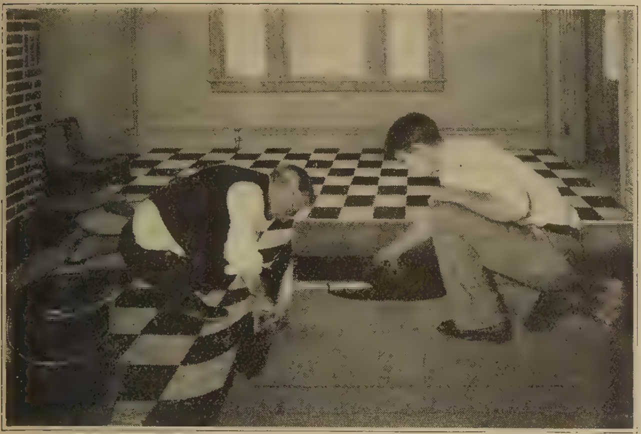
In the group of hard surfacings are included terrazzo, concrete tile, art marble, ceramics, marble mosaics and slate. Great freedom in design and color is now possible with all of these materials assuring floors that not merely supplement, but frequently dominate the beauty of interior decoration and design.

Terrazzo Floor Finish

A terrazzo floor consists of a concrete structural slab, a mortar base and a wearing surface or topping containing a high percentage of marble chips or other selected aggregate. The best practice calls for a combined base and surface thickness of 2 in.; never less than 1½ in. It is good practice to reinforce the base, usually with ½-in. mesh, No. 18 wire.

The mortar base for terrazzo is bonded to the structural concrete floor slab. The base course should be a 1:3 mix, using clean, coarse torpedo sand, and should be screeded to an even surface about ¾ in. below the finished floor level.

Metal strips, preferably of brass, about 1½ in. wide, 20 gauge, should be placed the entire length and breadth of the floor, not to exceed 5 ft. on centers, so that the top edge of the strips will be flush with the level of the finished floor. These strips are required in all terrazzo.



Linoleum and similar resilient floor coverings can be cemented directly to the surface of the concrete floor

In the wearing surface the aggregates are usually of three sizes, ⅛-in, ¼-in. and ⅜-in. The mix usually is 1 part portland cement to 2 parts of selected aggregate, with the coarse chips predominating, so that at least 85 per cent of the finished surface concrete will be of exposed stone. The mixture is spread evenly to a depth of ¾ in. and then rolled. Additional stone chips of the larger size are spread over the surface and rolled into the concrete. The surface is then floated fairly smooth and given one troweling.

Grinding should begin after the concrete has been wet-cured for five to seven days and when it has hardened sufficiently to prevent surface chips from being dislodged. The final finishing consists in covering the floor with a soap emulsion that is allowed to stand overnight. The surface is then scrubbed vigorously and finally rinsed with hot water to bring out the color.

Other Hard Surfaces

When surfaces of concrete tile, art marble, ceramics, marble mosaics or slate are desired, the following should be used as a guide:

The rough concrete floor is brought to within 2 or 2¼ in. of the desired level of the finished floor. The portland cement mortar for laying tile should be a 1:3 mix. Before the tile are laid they should be soaked in water for 10 to 20 minutes and then allowed to dry about the same length of time; the object being to have them uniformly damp, but never dripping wet.

Laying of the tile should begin in the center of the room so that opposite sides will require the same number of tile. This includes the full width outer border, if one is desired, and if any space is left, it should be filled with solid color tile to match the border. These should be cut to fit, except when the space is 1 in. or less in width. In this case it is best to fill the space with a well-mixed mortar made of equal parts of portland cement and fine sharp sand, colored with pigment to match the border.

Concrete tile, art marble, ceramic tile, marble mosaics and slate usually are laid with joints ranging from 1/16 to ½ in. It is recommended that directions for laying, given by manufacturers and distributors of these floor surfacing materials, be followed closely.

Resilient Surfaces

Plain, inlaid, jaspe or embossed linoleum, rubber or cork flooring or tile, and carpet are common types of floor coverings that provide resilient surfaces. These coverings, with the exception of carpet, are cemented to the concrete. The structural slab usually is satisfactory.

In every case, manufacturers' specifications for preparing the surface and instructions for laying the floor material should be followed carefully.

Linoleum Flooring

Where linoleum is to be laid the concrete floor should be screeded and steel troweled to a true, even surface. All surface irregularities should be removed. The concrete floor must be finished below the desired floor level, the thickness of the floor covering specified. The concrete floor must be clean, "bone-dry," and free from foreign material. A simple test for moisture in concrete may be made by placing pieces of linoleum face down on the floor —one at each corner of the room and another near the center, weighting the edges. After about 24 hours remove the weights and linoleum. If the floor is not entirely dry, the face of the linoleum and the floor itself will appear slightly damp.

Placing tile of resilient material over concrete. The tile units are cemented to the surface

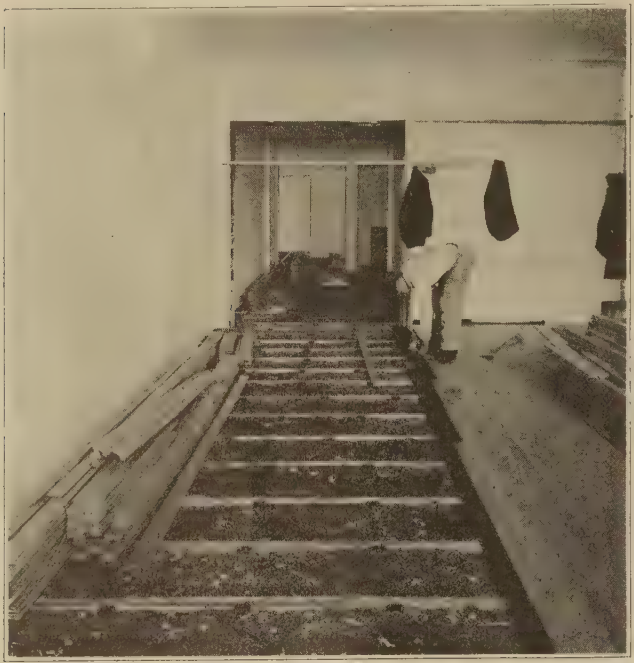
Linoleum may be cemented directly on concrete floors without the use of deadening felt, if the surface is troweled to a smooth finish and the extra resilience of the felt lining is considered unimportant. Solid colors of battleship linoleum are laid so that the edges overlap, and both thicknesses of the lap are cut at one time. Cutting through both thicknesses on a bevel provides an especially close joint. This method of jointing is not used with pattern linoleums.

Linoleum should be thoroughly rolled after laying, especially at joints. Sand bags or weights should be used to hold down these joints until the cementing material has fully set.

Cork or Rubber Floor Coverings

Where cork or rubber tile or flooring are to be laid, the concrete floor finish should meet the same requirements as for linoleum coverings. Here, again, the floor must be finished below the desired floor level, the thickness of the floor covering specified. The concrete floor must also be clean, "bone-dry," and free from foreign material.

It is best to submit a floor plan to the floor covering manufacturer for advice on the pattern layout and recommendations for best method of laying the material.



Showing how the wood flooring is nailed to sleepers fastened to the concrete with floor clips. The fill between the sleepers is cinders

Coverings of Carpet

At the time the floor is placed, wooden carpet strips, usually 1- by 2-in. lumber, should be embedded in the concrete around the border of the room. The surface of the floor is screeded and troweled flush with these strips. The finish should be about the same as for rubber or linoleum floor coverings; a smooth, even surface being desired. What is usually described as "sidewalk finish" is satisfactory.

To prolong the life of the carpet and at the same time add to its resilient and sound-proofing qualities, a carpet padding or cushion may be placed on the concrete floor before the carpet is laid. It is a simple matter to stretch the carpet and tack it firmly to the wooden strips around the border of the room.

Wood Surfaces

Where wood surfaced floors are desired in residences, the finest hardwood—maple, birch, beech or oak—can be laid over the structural concrete floor. Such practice is common in living and dining rooms, and floors so laid will not sag, creak or become warped.

The standard method of laying hardwood flooring over a structural concrete floor slab is to nail the boards to 2- by 2- or 2- by 3-in. sleepers. These sleepers may be embedded in the top part of the slab, held in place by a fill of cinder or other light-weight concrete, or fastened to metal or wire clips embedded in the concrete.

If the sleepers are embedded in the slab at the time the concrete is placed or if they are held in place with cinder concrete, they should be of bevelled stock. In any case, the sleepers should be placed not over 16 in. on center; preferably 12 in. in residential construction.

Before hardwood flooring is nailed to the sleepers, the concrete floor must be thoroughly hardened and free from moisture. It is also best to delay laying hardwood floors until after the plasterers have finished work.

Where hardwood flooring is to be laid over concrete on a wet fill or below grade, the structural floor should be waterproofed by an impermeable membrane placed within the slab. However, a creosoted underfloor and two layers of waterproof paper may be used in place of the membrane where moisture conditions are not too severe. Either method is common practice.

Certain types of parquet and design wood floorings are laid directly on the concrete. The surface should be troweled smooth and be free from moisture. No special topping is required, the ordinary level "sidewalk finish" providing a satisfactory base. The flooring is bonded to the concrete with bituminous cement. Manufacturers' directions for laying this type of wood flooring should be followed carefully, in order to insure satisfactory results in the finished floor.

Indiana Contractor Reduces Cost by Striking Off by Hand

A device which has proved of great value in striking off concrete street pavement is being used by Cecil D. Coil, a contractor of Fort Wayne, Indiana.

The device consists of a drum, which winds up a cable which draws the strike-off template forward. The drum is run from the mixer drum through a clutch which is operated by the mixer man.

The strike-off template is drawn forward by a cable attached to a drum on the mixer

When concrete has been placed in front of the strike-off template the mixer man engages the clutch and the template is pulled forward. Two men hold the template down on the forms and pull it back into position for another passage.

Mr. Coil reports that the device has saved many times its cost in the 4 years it has been in operation.

Highway Research Board Meeting in December

The ninth annual meeting of the Highway Research Board will be held on December 12 and 13, 1929, in Washington, D. C. at the building of the National Academy of Sciences and National Research Council.

An important feature of the meeting will be the presentation of progress reports upon the comprehensive program of highway research now in preparation by the board.

Construction of Groins and Revetments

Details of Design and Erection of River Bank and Coastal Construction in Great Britain—Alternative Arrangement of Groins

By MAJOR JOHNSTONE-TAYLOR

ONE of the most generally known means of arresting coast and river bank erosion, by the erection of groins, is used on the south coast of Britain where a good deal of this class of work has been successfully carried out in reinforced concrete. The construction outlined is peculiarly well suited to protection at the foot of comparatively soft cliffs. In the particular instance referred to the coast line is in the form of chalk cliffs which, as they become washed away, disappear except for the flints they contain. There being but little loose material, relatively high groins are advisable, which if timber is used, call for fairly heavy scantlings. The arrangement of the reinforced concrete groins adopted here as an alternative is shown in Figure 1. Each one is constructed of columns 16 in. square and spaced 5½ ft. apart for the first 200 ft. from the cliff and thence to low water 7 ft. The spaces between them are closed by 6 in. slabs one foot deep dropped into position in grooves moulded in the sides of the columns. The slabs are fixed in their grooves by cement grout run in from the top after the sides of the opening between slabs and columns are filled up with stiff cement mortar. The columns are fixed in holes excavated in the chalk to a depth of 2 ft. 4 in. and stand up 8 ft. at the cliff, being gradually reduced in height to 2 ft. 6 in. at the low water mark. In softer material the posts have been made long enough to drive as piles to a depth of 10 or 12 ft. The steel used in the columns consists of four 1¼ in. round bars disposed as shown and tied together by ¼ in. steel wire links at 6 in. centers with additional ⅜ in. steel rods to support the flanges. The slabs, which have chamfered corners, are reinforced by four ⅜ in. steel rods tied at 6 in. centers by ¼ in. steel wire links.

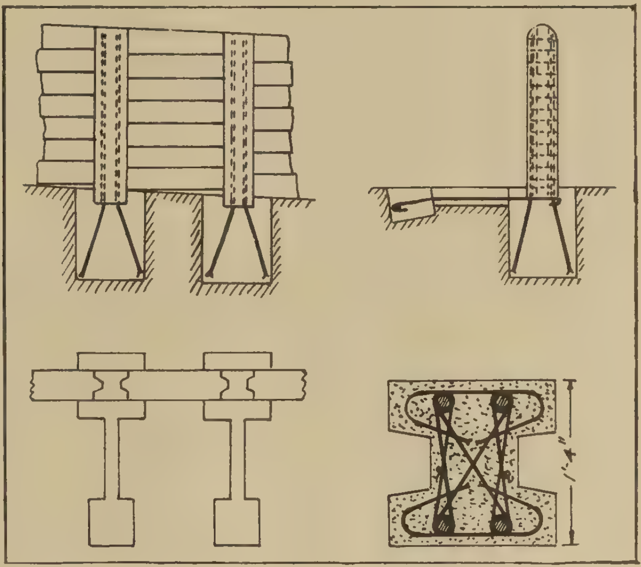


Figure 2

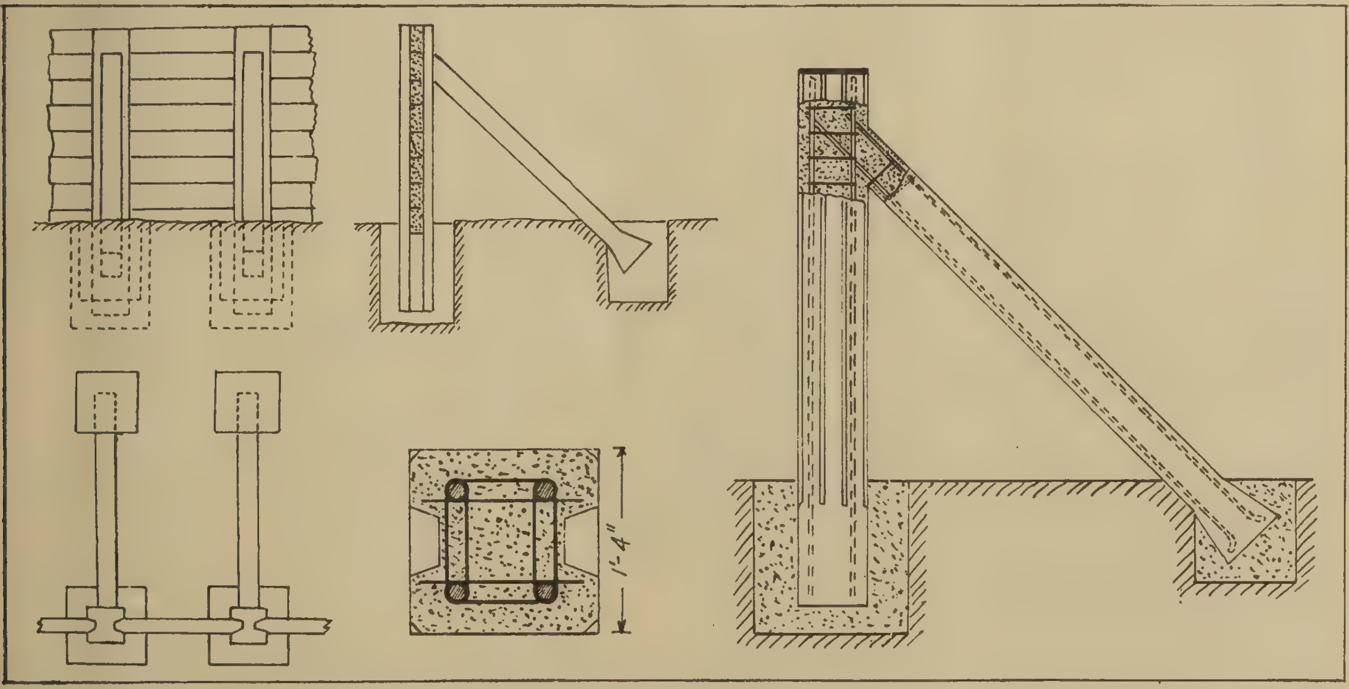


Figure 1

In many situations it can be anticipated that material will collect much more rapidly on one side of a groin than on the other so that additional protection may be called for in the form of a wall at the landward end of the groin on the leeward side, the latter being better constructed in such instances without any irregularity on the face. This alternative arrangement is shown in Figure 2, where the slabs are all made 16 in. thick so as to bring their surfaces flush with the columns. The tops of the groins are finished off smooth and rounded and without any projection of the column above them. No struts are used, but the columns are sunk somewhat deeper than with the previous construction and are provided with a system of buried tie rods on the windward side and are arranged in view of the possibility of scour taking place on the lee side of the groins.

The absence of projections obviates injury by any grinding action of the shingle and by their setting up but small disturbance of the water promotes conditions favorable to the deposition of shingle.

Revetments

The previously mentioned revetment walls are constructed on the lines shown in Figure 3.

They are not retaining walls, their purpose being to provide a hard, durable toe to the cliff during the period in which the groins are collecting material so that the construction may be carried out on relatively cheap lines.

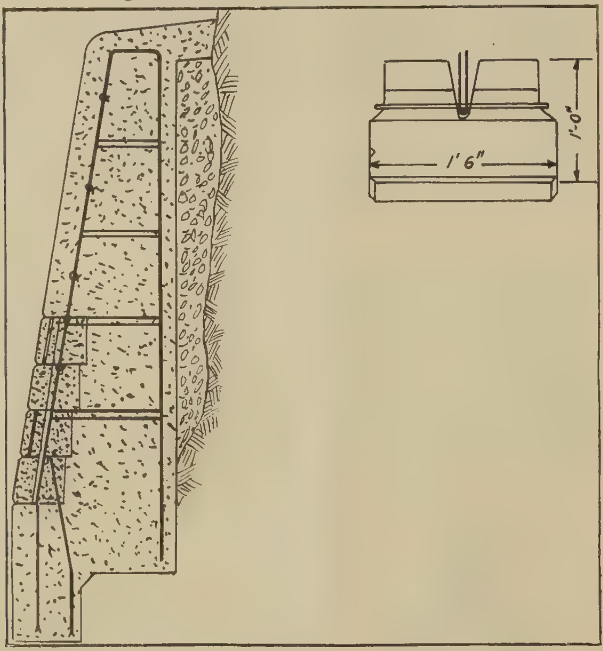


Figure 3

The face consists of granite concrete blocks for a height of 4 or 5 feet above shore level, the remainder of the wall being formed of shingle mass concrete reinforced with steel rods as indicated. From the detail of the block it will be observed they are small and light so as to be easily handled and they rely neither on their own weight nor upon that of the adjacent ones for stability but are tied into the wall face by means of steel reinforcement. These blocks are made 1 ft. thick, 1 ft. from face to back on top and 1 ft. 6 in. deep, the face having the requisite batter. Back, top and ends are moulded with grooves which effect a bond with the concrete backing and also admit of the insertion of steel rods to interlock with the main reinforcement.

These blocks have proved very successful and it should be noted that the steel rods are carried down into the foundation to assist in taking shear. The function of the reinforcement is partly to lock the facing blocks in position and partly to give some extra strength to the wall in view of its small thickness. Each wall is brought right up to the groin at one end and carried into the cliff at the other by means of a return end set at 45 degs. to the line of the wall and entering 2 ft. into a chase cut in the face of the cliff to receive it.

Survey Shows Extensiveness of Five-Day Week

The five-day or forty-hour week for building trades mechanics is probably the most important issue now facing the nation's building industry. To obtain the extensiveness of the five-day week movement, S. W. Straus & Co. has made a national survey of industrial conditions in this industry.

The result of this survey shows that the trend is rapidly swinging to the shorter work week and that at this time approximately 25 per cent of the building mechanics of the country are working on the basis of the forty-hour week.

Data and statistics on the short work week were obtained from builders in approximately 100 large cities that range from coast to coast, from cities along the Canadian border southward to the Gulf of Mexico. Builders in a large percentage of the cities responded with the desired information. This information furnished to S. W. Straus & Co. shows there are approximately 200,000 building trades artisans employed on the five-day week basis.

Officials of the building trades department of the American Federation of Labor estimate the membership of the organized building trades workers in the United States and Canada at 800,000.

The motivating force and backbone of the five-day week movement is furnished by the building workers of the metropolitan district of New York. It is estimated that of the 200,000 building workers now on the five-day schedule, 150,000 of them are New York craftsmen, 18,000 of the five-day week workers are Pittsburgh mechanics, and the remaining 32,000 are journeymen trades that have procured the 40-hour week in individual trades units in other cities.

Considerable impetus will be given the five-day movement if Chicago's 110,000 building workers succeed in procuring the five-day week. Most Chicago building trades received wage increases late this spring and early summer. There was some talk of the 40-hour week when contracts were being negotiated but this agitation was shelved when the trades were given a substantial wage increase. Recently, however, agitation for the five-day week has been started among the Chicago building trades. This movement began shortly after the short work week was conceded to the New York building workers. Chicago builders are now giving the 40-hour week consideration and some decision on the subject is expected soon.

Convention Date for Road Builders Approaching

Day by day plans are becoming more definite and complete for the twenty-seventh annual convention and road show to be held at the Auditorium at Atlantic City, New Jersey, January 11th to 18th.

The show will be held in what is said to be the world's largest auditorium and convention hall, offering 239,386 sq. ft. of estimated floor space. Other features of the city that are expected to prove attractive are the wide choice of hotels, entertainment facilities, and excellent transportation arrangements possible by land, air and water.

Buried Reservoir Design

The Calculation of Reinforced Concrete Water Reservoirs Buried Underground

By DAVID LANDAU

Part I

THE calculation of the elements of a reinforced concrete water reservoir to be buried underground calls for a somewhat different procedure than that followed in fixing the dimensions of a reservoir placed above the soil. If the ground is sufficiently compact then the earth pressure against the reservoir walls will act in a direction opposite to that of the liquid pressure within, which thus permits making the structure appreciably lighter and less costly than would be the case were the same dimensioned reservoir placed above the soil.

Buried reservoirs have the added advantage that, in general, they do not occupy needed space, require no protection from the elements of weather, do not need any special foundations, are not exposed to wind pressure and are out of sight. In some cases, in the writer's experience, the reservoir acts as a retaining wall for an adjacent building and part of the reservoir is made into a storage place underground where a uniform temperature is assured all year for materials used by the owner.

It must be evident that, were we to calculate the reservoir only for the water pressure within, without considering the counterpressure of the earth, then, of course, the reservoir would be too strong and miss the economic aspect of cost.

If, on the other hand, we consider the earth pressure, this must be done carefully since the refilling is never wholly effective and, therefore, the earth pressure is not the same as in an old soil. In making the calculations we must reduce the assumed pressure by some amount depending on the care of the workmen who refill as well as the nature of the soil. It is the custom of many to take the pressure at from ⅔ to ½ of the normal. Naturally, in time, the earth will take its usual place in the fill-in, aided by time and weather and thus become quite normal. If this be so, as it surely will, then our supposed factor of safety for the reservoir will simply increase, which is to our advantage.

Because the buried reservoir acts as a retaining wall for the surrounding earth and encumbrances, such as buildings, etc., the pressure produced by these elements should be examined in the design.

The reservoir cover or top may, at times, be so located as to carry not only the earth loads above it but, in addition, live-loads as well. In this case the entire reservoir must be sunk deep enough underground so that impacts will not harm it. In the minimum case the depth of the water surface when the reservoir is full should be about 30 in. from the top of the soil to avoid the effects of freezing in winter. If vehicles are to pass over the top, the depth should be increased and, depending on the conditions, an extra precaution might be taken by placing a series of monolithic beams directly over the top to prevent damage.

Size and Form of Buried Reservoirs

Buried reservoirs, like those placed above ground, may be made of any form—square, rectangular, cylindrical, or even elliptic—but the cylindric form has too many advantages over the others to consider them. Of course space considerations may force one to use one or other of the forms mentioned but then these other forms are rather the exception and we will not discuss them here.

In selecting the proportions for the reinforced concrete buried reservoirs, we see that the smaller the diameter the deeper will be the shell. This increases the hydraulic head on the sides and bottom and, consequently, the wall must be thicker and thus require more reinforcement. But this is not all. We must dig a deeper hole and the deeper we go, the more labor is required to remove a given volume of material. Especially is this true on small jobs. Increasing the diameter brings with it other difficulties of space consideration. It is, therefore, evident that there are factors which control, in a measure, the best proportions of diameter and height for a given volume. While one may show, theoretically, the best proportions suited to any given case, yet, to obtain a general idea, for average conditions we give a list of these in Table I. These are established from many reservoirs used under different conditions. The reader, we hope, will understand that the given proportions are not rigorously fixed and, therefore, may be altered, as they probably will be, to suit any given case. We merely give them as a guide.

TABLE I

Capacity in Gallons	Diameter, Ft.	Height, Ft.
5,000	10	9.50
10,000	13	11.00
15,000	15	11.50
25,000	19	13.00
40,000	23	14.25
50,000	24½	15.75
125,000	37	17.00

In the height column has been added a distance of about 12 in. to allow for the variation in volume due to irregularity and to be sure to be on the safe side.

These vary not only with the specific weight of the soil, its nature, etc., but also with the natural angle of slope of the soil material. Because of the molecular cohesion of the soil material, the thrust on the reservoir walls produced by the earth can never be as high as that of a liquid. On the other hand, when the soil is waterlogged and muddy, the earth thrust may almost equal that of the liquid in the reservoir. If the earth is really waterlogged then the reservoir, if not filled, may even float out of its mooring. In addition to the soil pressure or thrust one may have additional loads produced by a surcharge arising from loads placed adjacent to the reservoir, and to these again may be added live-loads, such as that of vehicles passing over the buried reservoir. Each case must be examined separately to see what effect they will produce on the resultant project.

Three cases of earth pressure must be examined. They are:

Case I—Where we have a vertical wall, as in the case of a reservoir buried underground, the thrust against the sides of this wall (see Figure 1) is given by the expression,

$$Q = A \cdot p \cdot H^2 \qquad (1)$$

Wherein, $A = \frac{1}{2} \tan^2 \left(45^\circ - \frac{\phi}{2}\right)$

p = the weight of the earth per unit volume — ft³.

ϕ = the natural angle of repose of the soil

H = the height of the wall, in feet.

Q = the thrust, in lbs. per foot.

Now, the center of gravity of the application of this thrust Q may be shown to be located at a distance of 1/3 of the height, H, measured from the base upward or:

$$a = H/3 \qquad (2)$$

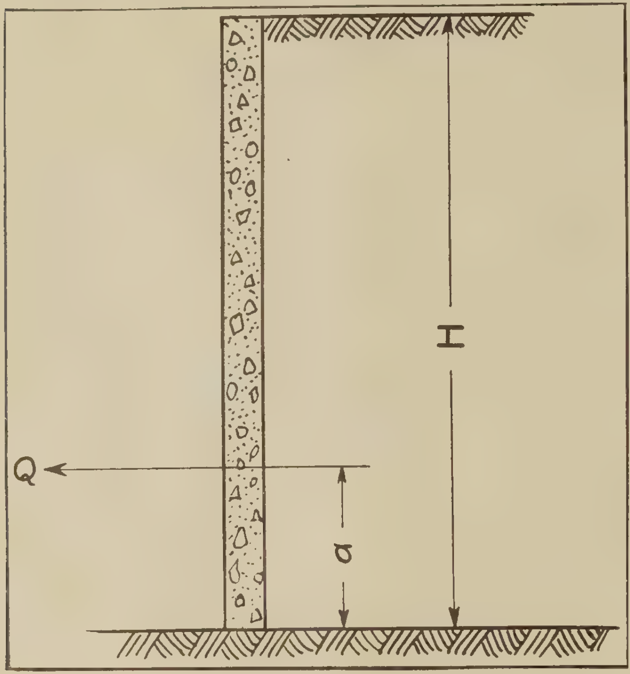


Figure 1

To facilitate the evaluation of the numerical results of equation (1) we give, in Table II, the values of A in terms of the angle ϕ.

TABLE II

ϕ	A
0°	0.5000
20°	.245
25°	.203
30°	.167
35°	.135
40°	.109
45°	.086
50°	.067
55°	.049
60°	.036

The values of p or weight of the soil per cubic foot and ϕ the angle of repose of different soils are given in Table III. These are approximate but may answer in many preliminary designs until more accurate figures are obtainable. It may be said that where the nature of the soil is not known at all one may take $p = 100$ lbs. and $\phi = 35^\circ$.

It is seen from Table III, that water, notwithstanding its lower weight per cubic foot, yet because of its angle of repose, ϕ, being zero, will give the greatest thrust. Its next nearest neighbor is mud.

The reader must not confuse the thrust acting on a vertical wall which, as we have seen, occurs at a distance of 1/3 of the height measured from the bottom edge upward, with the pressure on the same wall which is equal to double this thrust divided by the height.

The *thrust* of the soil due to any given height is the summation or integral of all the elementary pressures acting on this, while the *pressure* is the differential coefficient of the thrusts taken at infinitely small adjacent heights. The fact that the differential coefficient of a number to the second power is equal to double this number explains why the *pressure* follows the rule just enunciated.

TABLE III

Type of Soil	p(ft³)	ϕ (in Degrees)
Dry sand	90	30
Clay, dry	107	35
Clay, moist	109	40
Ordinary farm soil, dry	90	45
Ordinary farm soil, humid	120	40
Chalk	105	40
Compact soil	120	55
Crushed stone	100	45
Mud	115	20
Water	62.5	0

Case II—Where a surcharge rests on the soil we shall have an additional thrust due to same. If we call this surcharge load acting per unit area, generally per sq. ft., q, then the thrust produced by it is:

$$Q_1 = 2\,A\,q\,H \qquad (3)$$

where the letters have the same significance as in equation (1); see Figure 2.

The point of application of the thrust load, due to the surcharge, is at the height a measured from the lower edge of the wall and this is equal to,

$$a = H/2 \qquad (4)$$

We see then that the point of application of this surcharge thrust is at one-half the height of the wall and not at one-third, as in the case of the thrust due to the soil weight.

The pressure due to a surcharge is constant over the

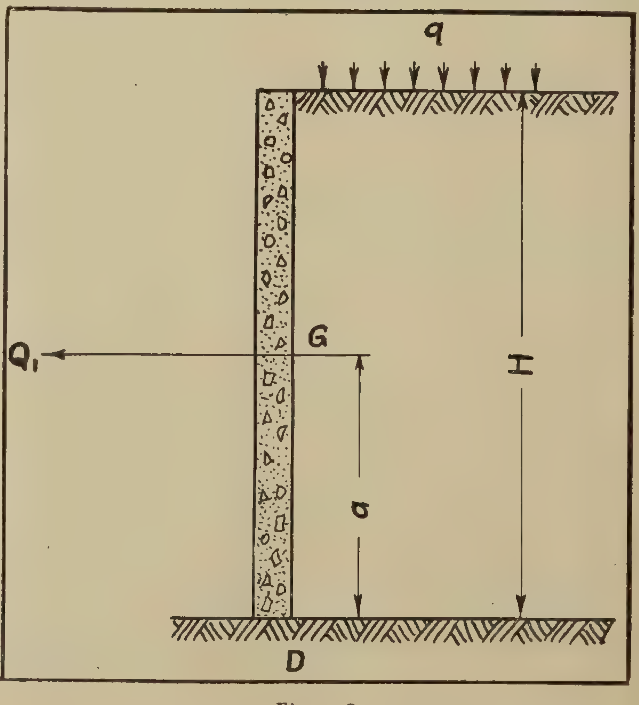


Figure 2

entire height of the wall, whereas soil thrust, due to the soil weight, varies from zero to a maximum, which is reached at the bottom of the wall.

As the two cases just discussed are the ones which occur most frequently, it may not be amiss to show their application by an example.

Let us suppose that we have a soil weighing 113 lb. per cu. ft., having an angle of repose $\phi = 45$ deg. and a wall height of, say, 20 feet. The thrust, due to the soil weight, per foot width of wall at this depth is from equation (1):

$$Q = 113 \times 0.086 \times 20^2 = 3{,}887 \text{ lbs.}$$

We again repeat that one must not confuse thrust, which acts at one-third the distance from the base, with the pressure, which is equal to double the thrust divided by the height. If we call this pressure P we have,

$$P = \frac{2 \times 3887}{20} = 388.7 \text{ lb.}$$

Of course at any other height the pressure is proportional to such height.

Suppose that we have a surcharge of 400 lb. per sq. ft. on the soil, what will be the thrust due to such surcharge on this same 20-ft. high wall? Substituting in equation (3) we get:

$$Q_1 = 2 \times 0.086 \times 400 \times 20 = 1375 \text{ lb. per ft. width}$$

And this is constant on the entire height of the wall while its point of application is at ½ H. Now, as in the case of the soil pressure, the pressure, which we may call P_1, due to the surcharge is:

$$P_1 = 2 \times 400 \times 0.086 = 68.8 \text{ lb.}$$

In Figure 3 we have plotted a diagram of the direct pressures. The triangle $A\ B\ C$ has a base of 388.7 lb. The integration of this triangle is equal to its area or ½ × 388.7 × 20 = 3887, which is the thrust due to the soil load found previously from equation (1).

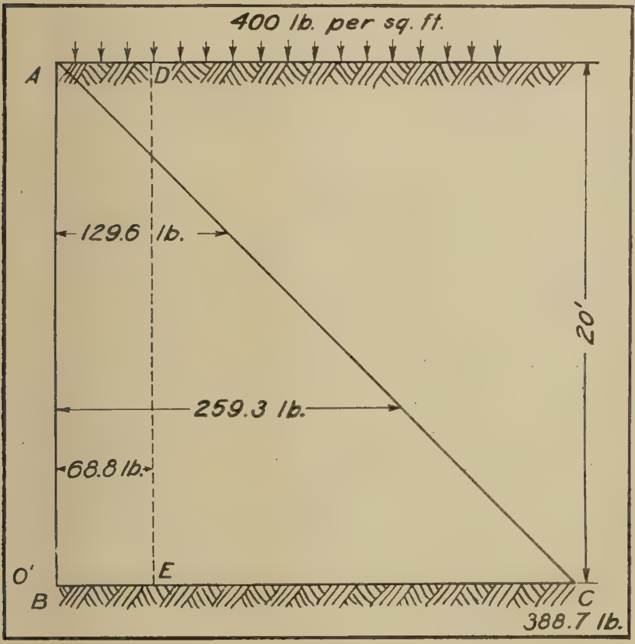


Figure 3

The pressure due to the surcharge is represented by the rectangle $A\ D\ E\ B$ whose base is 68.8 lb. The area of this rectangle is, of course, 68.8 × 20 = 1375 lb., which is the value Q_1, also found by calculation.

Case III—This case is rather rare. It is a condition in which the buried reservoir might find itself, at some time or other, partly submerged, or wholly so, as in case of an inundation with an earth filling on top. Of course, there are times when we strike a soil which may become flooded during heavy rain seasons. In this case it is essential that we provide drainage, otherwise the reservoir will become contaminated by infiltration.

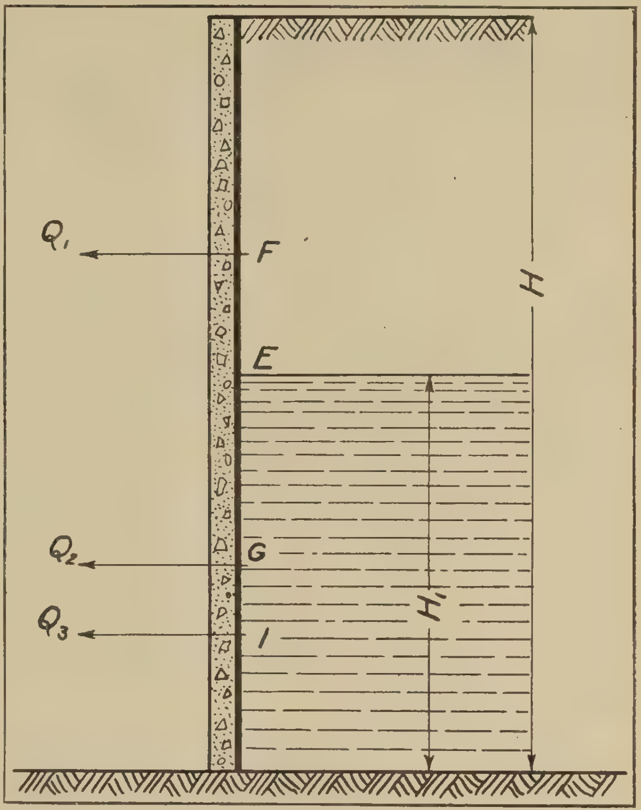


Figure 4

The total thrust is equal to Q, which in turn is made up of three separate thrusts, Q_1, Q_2 and Q_3, whose values are indicated in Figure 4. Let us consider each one separately:

(I) The dry soil fill-in,

$$Q_1 = A\ P\ (H - H_1)^2 \qquad (5)$$

The resultant F is given by

$$\text{DF} = \frac{2(H_1 + H)}{3} \qquad (6)$$

(II) Immerged soil:

$$Q_2 = A\ [(p - 62.5)\ H_1^2 + 2p\ (H - H_1)H_1] \qquad (7)$$

And the point of application of the thrust G is given by:

$$DG = \frac{H_1}{3} + \frac{pH_1\ (H - H_1)}{6p\ (H - H_1) + 3\ (p - 62.5)\ H_1} \qquad (8)$$

(III) And for the water,

$$Q_3 = \frac{62.5\ H_1^2}{2} = 31.25\ H_1^2 \qquad (9)$$

And the point of application I is given by:

$$DI = \frac{H_1}{3} \qquad (10)$$

The total thrust is:

$$Q = Q_1 + Q_2 + Q_3 \qquad (11)$$

For the special case where the soil may be completely under water

$$Q_1 = 0$$

$$Q_2 = A\,(p - 62.5)\,H^2 \qquad DG = \frac{H}{3}$$

$$Q_3 = 31.25\,H^2 \qquad DI = \frac{H}{3}$$

If there be a surcharge we must calculate its pressure and thrust as already shown.

(To Be Continued)

From the Products Associations' Bulletins

Wisconsin Concrete Products Association

JACK FRANKLIN, Secretary-Treasurer

ONE of the most recent Wisconsin association weekly letters concerns the subject of brands, quoting the state code and urging the use of identifying marks.

The fact that concrete masonry is the only hollow masonry unit in the United States is pointed out in a prior letter. It is stated also that in 1928 there were 48 concrete products manufacturers in the United States who had taken advantage of the Inspection and Certificate Service offered by the Underwriters Laboratories and received a fire rating on their blocks.

Addressed to the Wisconsin products manufacturer who is not yet informed of the importance of possible airport business, the Circular Letter No. 12, for August, of the Wisconsin association is entitled "Airport Hangars New Field."

It says in part, "A great deal of sales effort should be expended in this field, especially at this time, for in selling the city or county to the use of concrete masonry for the first job, you have practically sold them to concrete masonry for all future buildings of which there will undoubtedly be quite a number.

"Concrete masonry hangars have been constructed at many of the larger airports, some of which include the Wausau airport at Wausau, Wisconsin; Woodward airport, LeRoy, New York; University airport, Austin, Texas; Croydon airport, Croydon, England; Dennison airport, Atlantic, Mass.; Pan-American airways terminal, Miami, Florida, and the Rochester Municipal airport, Rochester, N. Y."

A late issue of the association's small monthly booklet has for its leading item a few words on "Quality Cast Stone," from which the following are abstracts: "Most cast stone manufacturers make concrete block and it should not be necessary to go through the same campaign for quality cast stone as was necessary to get quality concrete block.

"The plan that seems to be the most favorable is to have a copy of the proposed A. C. I. specifications sent to all architects. This will eliminate any possibility of architects not knowing how to specify cast stone.

Under "Advertising Best in Double Harness," it is said that "It is a truism of advertising, recognized by all who have had wide experience, that best results come from the use of supporting media—rather than from over-concentration in one medium. Returns from direct advertising can be greatly increased when the mailing is sent to names which have previously been cultivated by education advertising in a medium in which the prospect has confidence."

The same issue of the "Digest" contains a reprinting of a brief article from an industrial paper, entitled "Hints on How to Check Human Efficiency in Your Plant." Eighteen phases that enter into operation are listed in the form of questions.

Another item, under "Take Football for Example," says "A famous football coach once said, 'The best defensive is a good offensive.' This theory is quite readily applied to our concrete products industry.

"The first man to install new machinery, modernize his plant and adopt better methods, has a distinct advantage over his competitors. As others follow, this advantage is gradually cut down, the last ones to conform usually being forced to do so in the interest of self-preservation. In the meantime, however, the leader has taken another step forward and is again leading the parade.

"No manufacturer can make a greater mistake than to sit back and view with satisfaction a completed modernization program, secure in the belief that his work is done. It isn't done; it has just begun."

A successful sales manager's rules for selling are given as follows:

"There are, roughly, four groups of prospects.

"Group number one, keen, alert, quick thinkers, have to be told three times to be sold.

"Group number two have to be told five times.

"Group number three have to be told seven times.

"Group number four are the prospects you just have to make sign."

Iowa Concrete Products Association

R. L. GAVIN, Secretary-Treasurer

THAT permanent homes cost less is the theme of the first item contained in the September "Concrete Products News." It emphasizes the fact that in the average small home the extra cost of first class, enduring and fire safe construction is estimated to be approximately the amount required for the added maintenance cost of a shoddy home during the first five years. After five years the owner of the better home is actually saving money while his neighbor in the shoddily constructed dwelling is saddled with constantly increasing maintenance costs.

Following visits among Iowa products plants, the secretary reports his findings in the combined July-August issue of the "Concrete Products News."

One of his observations is that "One noticeable condition was that in every instance products men, members of the Iowa Concrete Products Association, were enjoying good business. Of course, all of them could handle more, but there was no disposition to sit and complain of how hard times were, how automobiles are ruining business, all the money going for gasoline and tires, nobody building, and the thousand and one alibis and reasons why products were not selling. Members seemed to have an entirely different viewpoint of the situation, and this was reflected in the business they were doing.

Reinforced Concrete Design Simplified

Chart A (20,000; 2,000; 15)
Chart A (20,000; 2,500; 12)

By JAMES R. GRIFFITH
Professor of Structural Engineering, Oregon State Agricultural College

American Concrete Institute Building Code

$f_s = 20{,}000$ lbs. per sq. in.

$f'_c = 2{,}000$ lbs. per sq. in.

$n = 15$

$$f_c = 800 \begin{cases} K = 131 \\ p = 0.0075 \end{cases}$$

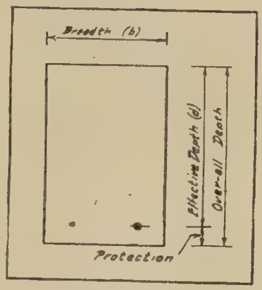
$$f_c = 900 \begin{cases} K = 157 \\ p = 0.0091 \end{cases}$$

$f'_c = 2{,}500$ lbs. per sq. in.

$n = 12$

$$f_c = 1{,}000 \begin{cases} K = 164 \\ p = 0.0094 \end{cases}$$

$$f_c = 1{,}125 \begin{cases} K = 196 \\ p = 0.0113 \end{cases}$$



$$M = K\,b\,d^2$$
$$A_s = p\,b\,d$$

As explained in the last issue, a series of charts are now to be presented so as to include the new building code of the American Concrete Institute. The charts herein presented are the first of the new series.

Considerable thought and discussion was given to the designation of the new charts. The charts of this issue solve the same type of problem as Chart A of the original series. The only difference is in stress limitation. So they will be given the same chart letter, differentiation being made by stress limitation. In making reference to charts, both letter and stress limitations will be given. Thus Chart A of the original series will be Chart A (18,000;2,000;15). Several slight changes are being made in the chart headings for quick reference and the convenience of the user. The original charts will be revised to conform to these changes when reprinted.

What advantage is to be obtained by the use of higher unit stresses in the concrete and steel? A question frequently asked but difficult to answer. There are many variables and uncertainties. Unit prices vary with geographic location and labor conditions. While unable to show financial comparisons, I want to at least show the relation of quantities. The individual reader can then arrive at his own conclusions with his unit prices.

Prof. Hardy Cross has said, "Scarcely any idea seems more definitely entrenched in concrete literature and practice than the conventional moment coefficients."* Why should any code specify how bending moments are to be figured? Too many self-called "designers" are faithful standard convention followers. I would call moment coefficients one of the Ten Commandments of concrete design, to be followed blindly and obeyed. But there they are, so I must make provision for them. The A. C. I. building code specifies that for fully restrained beams of approximately equal span, the bending moments shall be figured by

(1) Interior spans;

Negative moment at interior supports except the first,

$$M = \frac{w\,l^2}{12}$$

Positive moment near centers of interior spans,

$$M = \frac{w\,l^2}{16}$$

Thus the moment at the support becomes greater than at the center of the span. To provide for this larger bending moment without materially increasing the size of the beam the A. C. I. building code permits the use of a higher unit stress in the concrete specifying

Flexure f_c.

Extreme fiber stress in compression—$0.40\,f'_c$

Extreme fiber stress in compression adjacent to supports of continuous or fixed beams or of rigid frames—$0.45 f'_c$

This is analogous to a common inconsistency of design. Many times I have designed a member for specified loads only to be ordered to reduce the loads when the section became excessively large.

In order to provide for these higher concrete stresses I have added the necessary scales to the included charts. Thus on each chart of this issue will be found two breadth scales and two depth scales with their corresponding stress limits designated. When using one stress limit, use the breadth and depth scales marked for that stress. The approximate dead-load scale has been made for the lower

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*Vol. XXV, 1929 *Proceedings* of A. C. I.

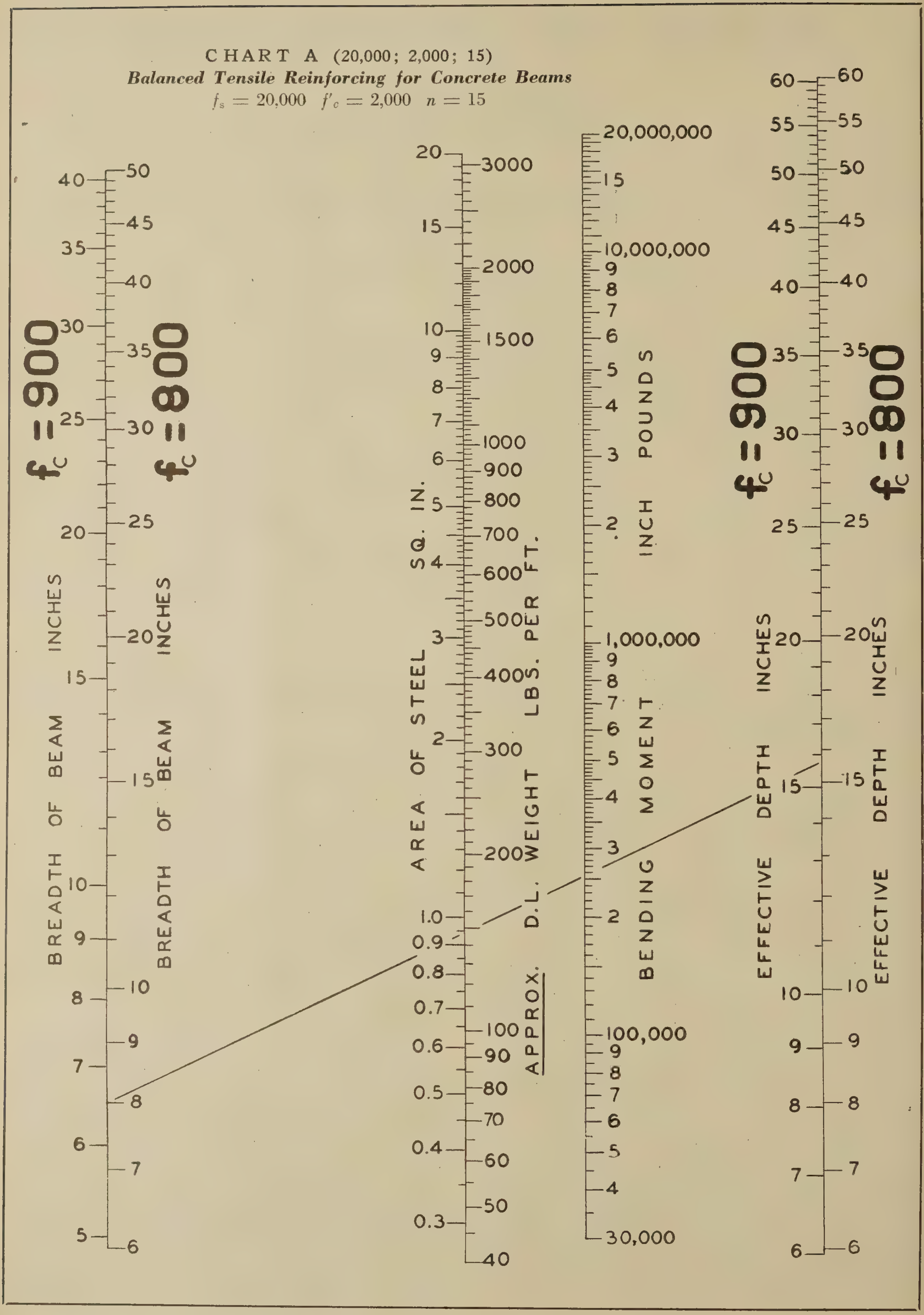


CHART A (20,000; 2,000; 15)

Balanced Tensile Reinforcing for Concrete Beams

$f_s = 20{,}000 \quad f'_c = 2{,}000 \quad n = 15$

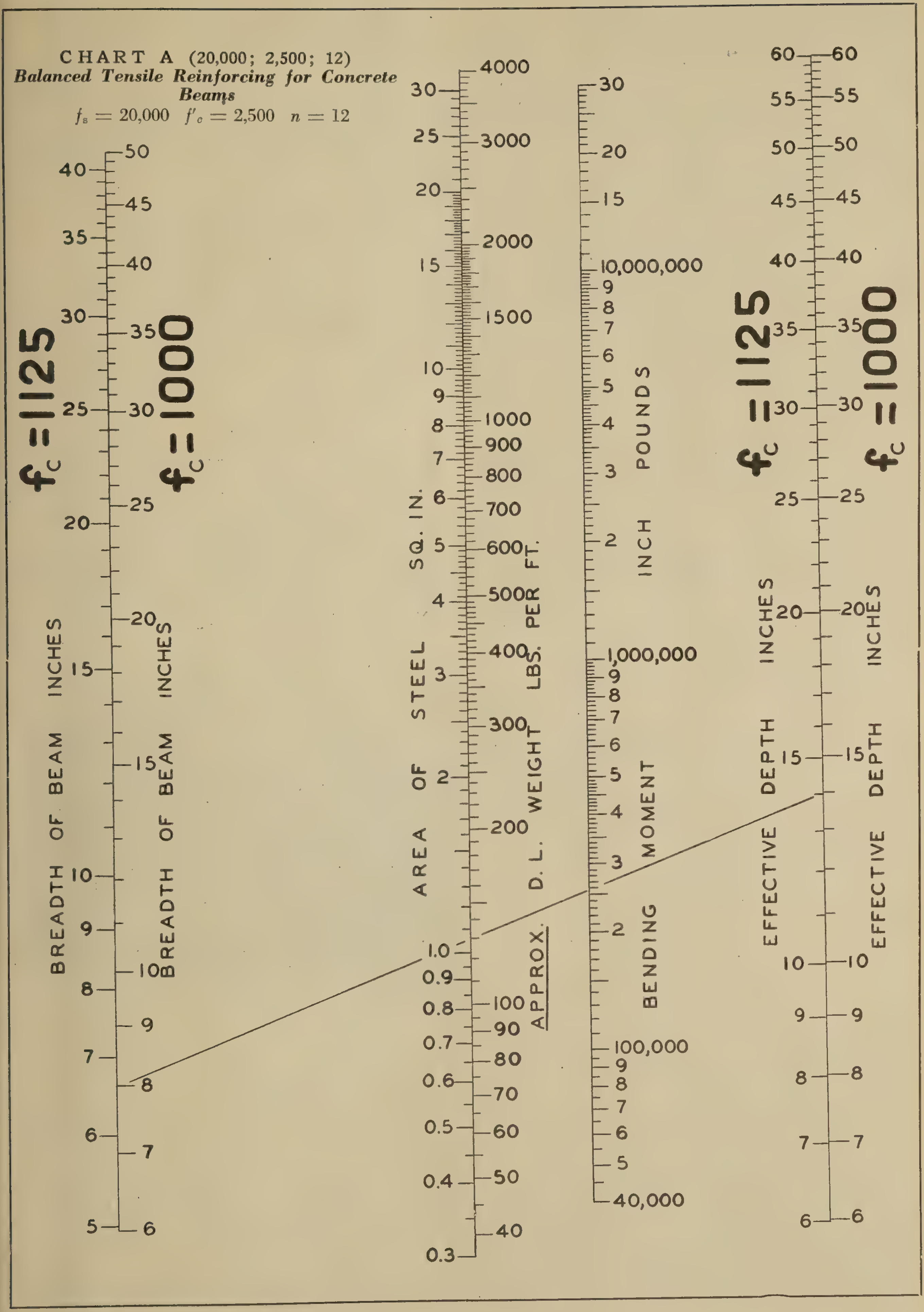


CHART A (20,000; 2,500; 12)
Balanced Tensile Reinforcing for Concrete Beams
$f_s = 20{,}000 \quad f'_c = 2{,}500 \quad n = 12$

stress in each case but will give a rough approximation for the larger stress.

A problem was solved under Chart A (18,000;2,000;15) of the original series for a bending moment of $M = 256{,}000$ in. lbs. Retaining the same breadth of beam ($b = 8$ in.), isopleths have been shown on each of the charts of this issue. The results are shown in the accompanying table of quantity comparisons.

QUANTITY COMPARISONS BASED ON BENDING MOMENT OF 256,000 IN. LB.

f_s Lbs./ Sq. In.	f_c Lbs./ Sq. In.	n	b	d	A_s Sq. In.	Concrete %	Steel %
18,000	800	15	8	15.2	1.07	100	100
20,000	800	15	8	15.7	0.94	103	88
20,000	1,000	12	8	14	1.06	92	99

Even quantity comparisons are difficult, due to the standards of form lumber and reinforcing steel. So in the table I have compared the required amounts instead of those actually to be used, basing all comparisons on the original solution as 100 per cent.

The charts of this issue were constructed with the same scales and relative scale spacing as used in the similar chart of the original series. The values at the construction isopleths are changed by the new stress limitations. This change only causes a shifting up or down of the scales.

In constructing Chart A (20,000;2,000;15) the (b) and (d) scales were first calibrated for the desired range. The construction isopleth was drawn through the values ($b = 6$) and ($d = 6$), giving for the other scales the following values:

$$A_s = p\,b\,d = 0.0075 \times 6 \times 6 = 0.27 \text{ sq. in.}$$
$$M = K\,b\,d^2 = 131 \times 6 \times 6^2 = 28{,}300 \text{ in. lbs.}$$
$$D.L. = \frac{9\,b\,d\,150}{8 \times 144} = \frac{9 \times 6 \times 6 \times 150}{8 \times 144} = 42.2 \text{ lbs. per ft.}$$

This will locate the central scales with reference to (b) and (d) for a concrete stress of $f_c = 800$. The outside scales could have been retained for the concrete stress of $f_c = 900$ by shifting the central scales. However, retaining the central scales and shifting the outside scales seemed to cause less confusion and be simpler for solution. The construction isopleth for the concrete stress of $f_c = 900$ would then go through the values

$$A_s = 0.27$$
$$M = 28{,}300$$

I then have, for $f_c = 900$, the following equations:

$$\begin{cases} b\,d = \dfrac{A_s}{p} = \dfrac{0.27}{0.0091} \\[2ex] b\,d^2 = \dfrac{M}{K} = \dfrac{28{,}300}{157} \end{cases}$$

Solving these two equations simultaneously for values of (b) and (d) I have

$$d = \frac{28{,}300}{157} \times \frac{0.0091}{0.27} = 6.07 \text{ inches}$$
$$b = \frac{0.27}{0.0091 \times 6.07} = 4.88 \text{ inches}$$

These values at the construction isopleth will give the information for starting the new (b) and (d) scales.

In constructing Chart A (20,000;2,500;12) the (b) and (d) scales were calibrated. For a concrete stress of $f_c = 1{,}000$, the central scales will then have at the construction isopleth, through $b = 6$ and $d = 6$, the following values:

$$A_s = pbd = 0.0094 \times 6 \times 6 = 0.3385 \text{ sq. in.}$$
$$M = Kbd^2 = 164 \times 6 \times 6^2 = 35{,}400 \text{ in. lbs.}$$
$$D.L. = \frac{10\,bd\,150}{144 \times 9} = \frac{10 \times 6 \times 6 \times 150}{144 \times 9} = 41.7 \text{ lbs. per ft.}$$

It will be noted that I have varied the amount of protection to conform with the changes. Retaining the central scales, for a stress of $f_c = 1{,}125$, the construction isopleth through $A_s = 0.3385$ and $M = 35{,}400$ will give the equations:

$$\begin{cases} b\,d^2 = \dfrac{35{,}400}{196} \\[2ex] b\,d = \dfrac{0.3385}{0.0113} \end{cases}$$

When I solve these two equations simultaneously the following values are obtained:

$$d = \frac{35{,}400}{196} \times \frac{0.0113}{0.3385} = 6.025 \text{ inches}$$
$$b = \frac{0.3385}{0.113 \times 6.025} = 4.97 \text{ inches}$$

This gives me the necessary information for starting the new (b) and (d) scales for the stress of $f_c = 1{,}125$.

Bending Reinforcing Rods with Crane and Bucket

The Cooksville Company Limited of Canada found a novel use for their grab bucket during their recent building program at their plant in Cooksville, Ontario.

H. D. Holland, their superintendent, says: "During our building program, our Link-Belt crawler crane performed valuable service in excavating, handling aggregates, erecting steel and placing heavy machinery.

"At one time we were confronted with the problem of bending reinforcing bars for our concrete forms. The task was performed by placing several rods through the arms of our Hayward clamshell bucket and then opening the bucket, thereby bending the rods to the exact shape required."

COMING CONVENTION

American Road Builders Association — January 11th to 18th, 1930. 27th annual convention and road show, at Atlantic City, New Jersey.

The Design of Concrete Paving Mixtures

Interrelationship of the Materials Used in Concrete—Strength of Concrete Determined by Binding Power of the Cement Paste—Function of Fine Aggregate—How Proportions Are Determined—The Mortar-Void Method of Concrete Design Explained—Arriving at the Amount of Water To Be Used—Fixing Proportions by Weight—Field Procedure—Beam Tests

By E. R. KENDALL
Assistant Director, State Highway Laboratory, Ann Arbor, Mich.

TO properly design concrete, from the standpoint of the engineer, knowledge is required of how to produce certain results in a specified length of time, at the least cost, using the materials that are available.

At the beginning of the 1928 construction season, it was the intention of the Michigan State Highway Department to determine the proportions by weight of the ingredients that enter into the composition of concrete paving mixtures, in order to obtain the maximum strength. The cement content was to be kept constant, using six sacks of cement per cubic yard of concrete. The aggregates used were to be the same as before: that is, specification sand and gravel or crushed stone, while the quantity of mixing water was to be such as to give a slump of about 1 in.

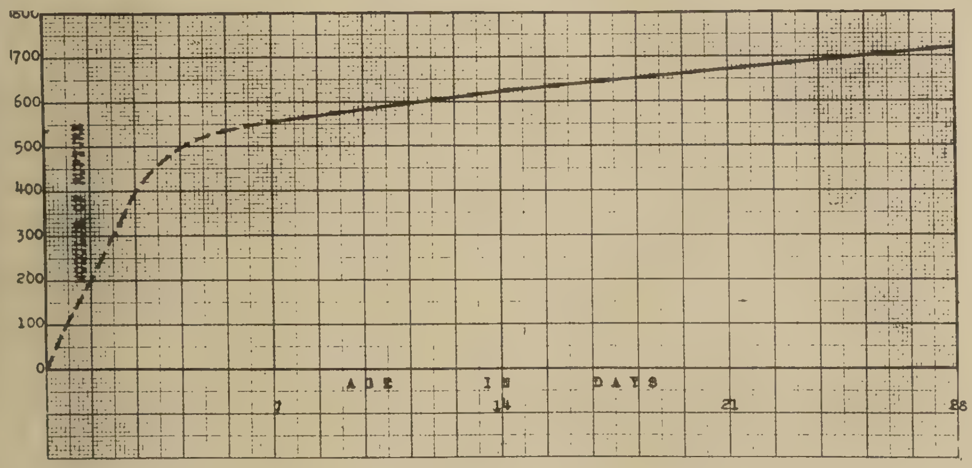
In treating this subject, an attempt will be made to show the interrelationship of the different ingredients used in concrete, and then to describe the methods by which the proportion of each material is determined.

To determine the influence of the several ingredients upon each other, it would appear logical to study: First, the combination of the water and cement in forming cement paste; second, the addition of sand to the cement paste, forming mortar, and finally, the introduction of coarse aggregate to the mortar to give concrete.

The Cement Paste

It is evident that the strength of concrete depends upon the binding qualities of the cement paste, since the aggregates themselves have no binding value. With a given cement, it is probable that the strength would be at a maximum if only enough water were used to combine chemically with the cement. Dry cement contains about 50 per cent air voids. One can conceive that the addition of water to the cement up to a certain point might fill a portion of the voids without appreciably changing the volume of the resulting paste. Beyond that point, the addition of water increases the volume of the paste, and dilutes the mixture. This dilution of the cement paste would reduce the binding power, with a resulting decrease in the strength. Therefore, the ratio of the quantity of cement used to the resultant voids would be a measure of the strength of the binding material.

As one studies the various methods of proportioning, there is brought home the very significant fact that all of the methods which give satisfactory results are based on the same fundamental principle; namely, that with a given



Curve showing increase in strength of concrete as determined from field tests of the modulus of rupture on 6- by 8- by 40-in. beams

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Presented at the Fifteenth Annual Conference on Highway Engineering, University of Michigan, Ann Arbor.

cement, the ratio of cement to the voids would constitute a yard stick for measuring the strength. If the voids in the cement paste are entirely filled with water, the case in question becomes a direct application of the water-cement ratio theory.

Function of Fine Aggregate

The chief reason for adding sand to the cement paste is to reduce the cost of the mortar. It would appear that the most economical thing to do would be to add sand up to the point where the voids in the sand were filled with the cement paste. Due to the inherent characteristics of different kinds of sands and cements, this cannot be done without creating voids, the magnitude of which is different for each kind of sand and cement, and for each ratio of sand to cement. These voids have a dilution effect on the cement paste, with a consequent reduction in possible strength. Therefore, for a given quantity of cement, the amount of sand to be used should be such that the least possible voids will be obtained in the mortar.

It is evident that, within limits determined by the workability of the mix, the addition of coarse aggregate to the mortar increases the volume, thus reducing the cost of the concrete. The maximum strength with a given cement content would be obtained if the mortar just filled the voids in the coarse aggregate. This, however, for pavement work results in a mix that is too harsh. An excess of mortar must be provided in order to make proper finishing possible. Therefore, to make a workable mix, the gravel particles should be distributed more or less like plums in a pudding. The excess of mortar that is required in order to insure workability has been determined by actual trial, and we have decided that, after the voids in the coarse aggregate have been filled, there should be an excess of mortar equal to about two-thirds of the voids in the coarse aggregate. If the cement content in the mortar is kept constant, the addition of coarse aggregate to the mortar will not affect the strength, because the strength of the mortar is the strength of the concrete.

From the foregoing, we conclude: First, that the strength of the concrete depends upon the building material, which may be measured by the ratio of the cement to the voids, the voids being air and water; second, that by adding the sand to cheapen the mix, voids are created which have a direct bearing on the strength of the resulting mortar; and third, that the gravel is added as a further diluent, but the maximum amount that may be added depends upon the workability, which, if the cement content in the mortar is kept constant, does not affect the voids in the concrete, and consequently the strength.

Determining Proportions

To determine the actual proportions, by weight, of the ingredients used in concrete, we follow Talbot and Richart's method (more commonly known as the mortar void method), which appears to be highly adaptable on jobs where weight proportioning of materials is used. This method is described in Illinois Engineering Experiment Station Bulletin Number 137. Up to this time we have applied this theory to our requirements in rather a restricted manner, and have found it possible to develop a laboratory procedure which renders the application simple in the field, but we wish to give credit to Messrs. Talbot and Richart for their method of design.

In order to understand the mortar void method of design, it is necessary to have a clear conception of the term "absolute volume." Visualize 1 cu. ft. of solid steel, weighing—say 490 lbs. One cubic foot, then, is the absolute volume of 490 lbs. of steel. Now imagine a similar block of steel, which, instead of being solid, is honeycombed with numerous air pockets. It would be found to weigh—say 245 lbs. The apparent volume is 1 cu. ft., but the absolute volume is only five-tenths of a cubic foot, because in reality there is only 50 per cent as much steel in this specimen. In other words, if this latter specimen were melted down into a solid mass, it would occupy only five-tenths of a cubic foot. In a like manner, the apparent volume of the concrete-making materials is quite different from their respective absolute volumes, except, of course, in the case of water. For instance, a cubic foot of gravel has about 40 per cent voids, and has an absolute volume of only six-tenths of a cubic foot.

Quantity of Mortar Needed

In this particular design we have assumed the excess of mortar over the voids in the coarse aggregate to be nearly constant. Since the weight per cubic foot of the loose surface-dry coarse aggregate is a measure of the voids, the volume of mortar will equal a constant times the weight per cubic foot of the coarse aggregate. Now the mortar (m) is also equal to the unit volume of the concrete minus the absolute volume of the coarse aggregate in the concrete (b), or ($m = 1 - b$). These relations can be expressed by the following equation ($kw = b$), where k is a constant (0.0124 divided by the specific gravity of the coarse aggregate), w is the weight per cubic foot of the loose, surface-dry coarse aggregate, and b is the absolute volume of the coarse aggregate in a cubic foot of concrete. The constant (0.0124) insures a workable mix, and was determined by making up trial batches. For a given weight per cubic foot of coarse aggregate, weight proportions of the coarse aggregate in a cubic foot of concrete may be obtained by multiplying its absolute volume (b) by the weight per cubic foot of its solid mass (specific gravity of coarse aggregate multiplied by 62.4). Since the cement content is assumed to be constant (that is, six sacks of cement per cubic yard of concrete) the only proportions that we now have to find are the water and sand, which can be determined from the mortar void characteristics.

The mortar void characteristics of the particular kind of sand and cement used are obtained by mixing various proportions of cement, water and sand, and determining the resultant percentage of voids. It may seem like a rather laborious task to determine the percentage of the voids in the mortar with varying proportions of cement, water and sand, but in reality it is quite simple. Small batches are made up and tamped in the usual manner in small metal cylinders of known volume. The voids for each proportion, being the space occupied by air and water, are simply the difference between the volume of the batch and the absolute volume of the cement and sand.

The actual laboratory procedure consists in determining the volume of batch of mortar of varying ratios of sand to cement and varying consistencies. The proportions of sand to cement are such that the ratios of the absolute volume of sand to the absolute volume of cement are 1.5, 2, 2.5, and 3. With a given ratio of sand to cement, just enough water is added to give a mortar of a dry consistency. Then successive increments of water are added until a mortar of practically a liquid consistency is obtained. After each increment of water, we find the weight of the mortar in a 2-in. by 4-in. brass cylinder whose exact volume is known. The volume of the batch is equal to the product of the volume of the cylinder and the total weight of the mortar in the batch, divided by the weight of the mortar in the cylinder.

Water Content

From the mortar void characteristics it has been found that, for a given proportion of sand to cement, a definite amount of water will give the densest mortar or the least voids. The addition of more water, or the use of less water, will only increase the voids. The amount of water used to give the densest mortar is called the basic water content. The basic water content does not give a plastic mix, but we find that with the coarse aggregates commonly employed, the water necessary to give the required workability is about 20 per cent more than the basic water content. This is expressed as a relative water content of 1.2.

The actual proportion, by weight, of water will depend upon the relative proportions of sand to cement, in addition to their individual characteristics. To obtain the maximum strength for a given proportion of sand to cement, the water required would be the amount that would result in the least voids in the mortar. As previously stated, it is impossible to pour pavement concrete with a mortar of this consistency, so that the water used is about 20 per cent more than the basic water content. Consequently, as soon as the ratio of sand to cement is known, the amount of water can be easily computed from the basic water content for that particular proportion of sand to cement.

In order to estimate this ratio, voids are determined in mortar which is made up with a relative water content of 1.2, using varying proportions of sand and cement. From these data a curve is drawn, showing the relationship between the voids in the mortar and various proportions of sand and cement. Mathematically, this curve may be represented by the equation $[V_m = f(a_m/c_m)]$, which indicates that the voids in the mortar (V_m) are some function of the ratio of the absolute volumes of the sand (a_m) to the cement (c_m). This curve, or equation, constitutes one of the fundamental relations of the mortar void theory of design. The other fundamental relation is $(a_m + c_m + v_m = 1)$, which means that a unit volume of mortar is made up of the sum of the absolute volumes of the sand (a_m) and cement (c_m), plus the voids (v_m) (air and water).

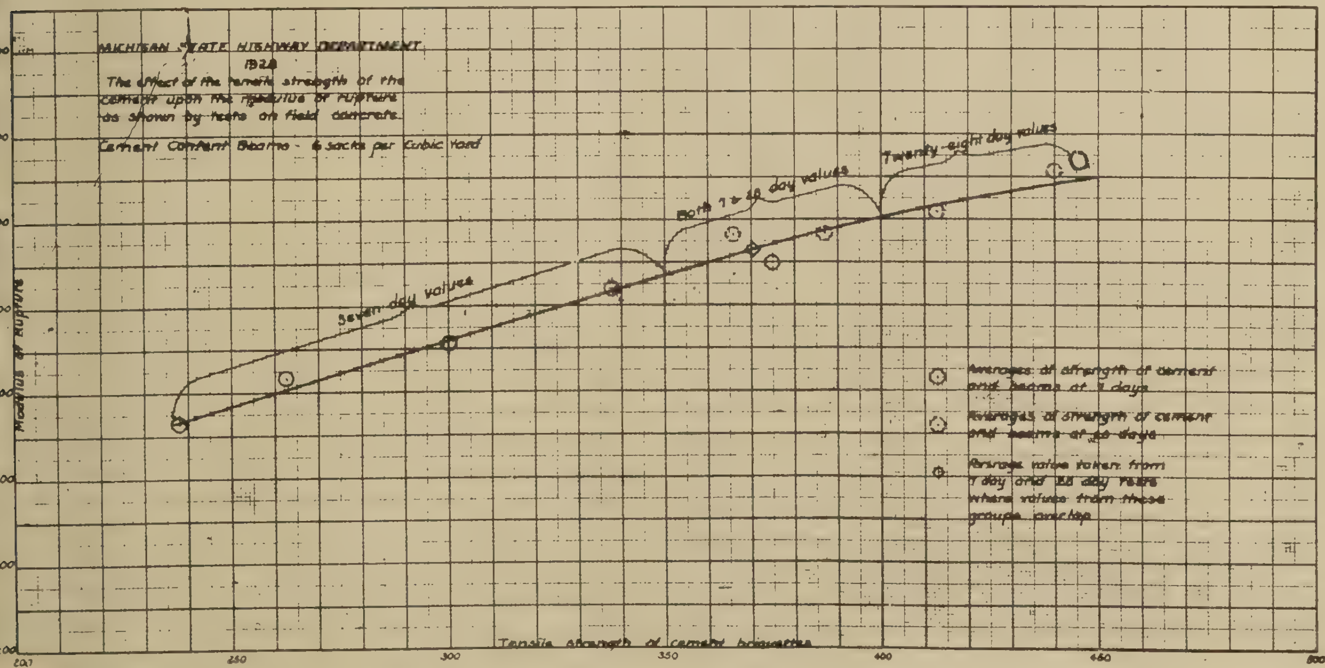
We now have two independent equations and two variables; namely, the absolute volumes of the sand, and the voids in the mortar, since the absolute volume of the cement per unit volume of mortar can be readily determined. This may be computed by dividing the absolute volume of cement in a unit volume of concrete by the volume of the mortar per unit volume of concrete. The absolute volume of cement per cubic foot of concrete is about 0.108 cu. ft., since it is assumed that six sacks of cement will be used per cubic yard of concrete. As stated before, the volume of mortar per unit volume of concrete may be determined for a given weight per cubic foot of the coarse aggregate. Solving these two equations simultaneously, the absolute volume of the sand to be used in the mortar may be determined.

We know the absolute volume of the cement, water and sand in a unit volume of mortar, because, not only is the cement content fixed, but after determining the absolute volume of the sand, the ratio of the cement to the sand can be obtained, and the amount of water computed. In order to determine their respective absolute volumes in a unit volume of concrete, each must be multiplied by the volume of mortar in a unit volume of concrete. This volume of mortar may be ascertained by subtracting the absolute volume of the coarse aggregate (b) from the volume of the concrete. Since for a given weight per cubic foot of coarse aggregate "b" can be determined, we now can find the absolute volume of the cement, water, sand and coarse aggregate in a unit volume of concrete.

Fixing the Proportions by Weight

In order to determine the proportions by weight of the ingredients that enter into the composition of concrete, the absolute volumes of the cement, water, sand and coarse aggregate should each be multiplied by the weight of the unit volume of solid material. The weight, in pounds, of a cubic foot of the solid material may be obtained by multiplying its specific gravity by the weight of a cubic foot of water (62.4 lbs.). If the unit volume of concrete is taken as a cubic yard, and each of the weight proportions is divided by six, it will give the proportions by weight per sack of cement, since six sacks of cement are required per cubic yard of concrete. These proportions, of course, are based on a definite weight per cubic foot of the coarse aggregate.

Since the excess of mortar is kept nearly constant, as is also the cement content, an increase of the voids in the



Curve showing the effect of tensile strength of the cement upon the modulus of rupture as shown by tests on field concrete coarse aggregate would have a tendency to make the mortar leaner. In order that the use of six sacks of cement will yield only a cubic yard of concrete, the proportions of sand and water must be varied with the weight per cubic foot of the coarse aggregate, since this weight is a measure of the voids.

The proportions by weight of the cement, water, sand and coarse aggregate are then determined for the various weights per cubic foot of the loose, surface-dry coarse aggregate, and these data are plotted on the chart similar to those now in use in the field.[1] These mortar void charts, made up in the Michigan State Highway Laboratory at Ann Arbor, are based on samples of the materials actually used in the various weight proportioning jobs throughout the state.

In order to set his batch weights, the engineer in the field is required merely to determine the weight per cubic foot of the loose, surface-dry coarse aggregate. With this information he can read from the charts the weight proportions of the water, sand and coarse aggregate per sack of cement. Of course, moisture determinations of sand and coarse aggregate are made in the field, the weight of the surface water found being deducted from the weight of the water shown on the chart, and the fine and coarse aggregate weight proportions taken from the chart being increased by the weight of their surface moisture.

On the basis of this reasoning, we believe that the weight proportions obtained will give the greatest strength possible, using six sacks of cement to a cubic yard of concrete, and maintaining the required workability. In a word, since the strength is proportional to the ratio of the cement to the voids and the cement content is constant, the only way the strength can be increased is to reduce the voids to a minimum.

Beam Tests

In order to measure the strength attained by this design, 6 by 8 by 40 in. concrete beams are made. Three beams are made from a single batch of concrete for every half mile of pavement, and at important intersections, in order to determine if the strength attained is sufficiently high to open the pavement to traffic. The method of making and breaking the beams conforms to the Pennsylvania State Highway Department standards. The molds are merely filled with concrete, the sides spaded, and the top struck off with a straightedge. The beams are broken at 7, 14 and 28 days, respectively, two breaks being obtained from each beam. The machine for breaking the beams is of the ordinary cantilever type, the initial load applied being 50 lbs., and the load is increased in increments of 50 lbs. up to 250 lbs., and then in increments of 10 lbs. up to the breaking point. Intervals of five seconds are allowed to elapse between each application of the load. The modulus of rupture is obtained by making the proper substitution in the formula: $(m = w_3 + k)$, where m is the modulus of rupture in pounds per square inch, w_3 is the load in pounds applied to break the beams, and k is the constant of the machine.

However, we desire, in the coming year, to design for a definite strength, rather than for the maximum strength which, keeping the cement content constant, means the least voids consistent with workability. Probably the strength of the modulus of rupture will be about 700 pounds per square inch, at 28 days. This will necessitate making a series of tests in order that we may obtain the constants in the strength equation, the constants depending, of course, on the tensile strength of cement used, time of mixing, curing conditions, temperature, age, etc. The variables, cement and voids, can be determined by proper substitution in the two fundamental mortar void equations.

In a discussion of this sort, it is rather difficult to present a working plan of this method of design, but if one actually goes through the process of the design step by step, he will find that it is not so difficult to grasp as he might suppose. The ideas presented by Talbot and Richart are a little different from those to which we have been ordinarily accustomed. Consequently some of the concepts are more or less elusive until they are checked by actual experience in working them out.

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[1] This chart was published on page 33 of the May, 1929, issue of CONCRETE.

7-Day vs. 21-Day Curing for Concrete Buildings

Tests Indicate Value of Longer Curing Time

By **HARLAN H. EDWARDS, C. E.**
Supervising Engineer, Scripps College, Claremont, California

Results of tests made on several reinforced concrete structures in Southern California indicate the value of thorough curing of the concrete structure. While standard and approved specifications require curing for a period of from 7 to 10 days, tests indicate that the structure so cured and then permitted to dry out has substantially such strength of concrete in 28 days as is attained at the time curing ceases.

These tests were the outgrowth of several years of experiences in concrete placing and testing on quality structures. When construction operations were started on Scripps College at Claremont, California, in 1927, particular attention was given to the curing of the structures to the end that maximum strength be developed from the material used.

Early in the progress of the work, tests were made of cylinders cast in a section of 8-in. wall and wet down for a week as is usually specified and done. The wall then was left to the weather and the cylinders were broken out for test at 28 days. Quality cylinders were cast at the same time these were cast in the wall, from concrete of the same batch and sent after two days to the laboratory for curing and testing at 28 days.

The resultant average strength was 1103 lbs. per sq. in. as compared to the laboratory-cured quality cylinders of 2164 lbs. per sq. in. Day and night air temperatures were such as would have produced higher strengths if kept wet longer. This thoroughly verified computations and previous 7-day tests of similar concrete cured in the laboratory and led to the requirement that on all work concrete was to be kept damp by repeated wettings for a period of 21 days, the frequency of wetting to be dependent upon weather conditions.

New Books

Testing Society's Proceedings

PROCEEDINGS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS. Published by the Society, at Philadelphia, Pa.

These annual proceedings make their appearance this year in two volumes. Part I (1184 pages) contains the annual reports of 42 standing and research committees and three joint committees of the Society, as well as 81 tentative standards which have either been revised or are published for the first time. This part includes also the annual address of the president and the annual report of the executive committee.

Part II (904 pages) contains 46 technical papers with discussion.

Concrete for the Builder

“IT has been a long winter!”

In the spring when the ground begins o thaw this is the by-word of the builder who has been idle during the cold weather period. On the other hand, the progressive concrete contractor who has kept his crew intact and his equipment in regular use speaks with enthusiasm:

“It has been a short, but profitable, winter!”

There is just as much of an opportunity to merchandise your services in winter as in summer.

—‡—

AN example of profitable winter work is the method followed by one contractor who contracts to do inside repair work for ndustrial concerns in his vicinity. There are many plants which have concrete floors that need repairing, and there are just as many which can be convinced that the advantages of concrete floors, properly built, are many. Building these floors means work for the concrete contractor—work that can be done in the winter.

There is hardly a factory, warehouse or other industrial building which has been in use for a number of years that does not offer work for the concrete builder. The builder who investigates this field can develop winter business.

Basement floors in residences and, in rural communities, floors in farm buildings offer other markets for the services of the concrete contractor in winter.

—‡—

WHILE the crew and equipment are busily engaged in carrying out contracts for winter construction, either inside or outside work, the builder himself or his sales organization should be making plans for operations in the spring.

Returning again to the subject of winter work, the cold weather months offer an excellent opportunity for the builder to take stock of his machinery, tools and other equipment. A few hours spent in repairing equipment in the winter will save many hours delay in the spring by preventing “breakdowns” and other mishaps.

Many building, factory and home owners will consent to having concrete improvements made in their properties during winter months if the advantages of such improvements are pointed out to them. The winter market offers a good opportunity for the builder to demonstrate his salesmanship. In doing this a survey of the territory may be required.

For example, it will be noticed that the loading platform of Smith & Company is badly in need of repair; this means a chance to sell a new one built of concrete. Likewise, the concrete floor in the plant of John Jones & Sons is broken in several places; this can mean another job.

—‡—

HOME modernizing work can go on, winter or summer. As has been indicated already, in many old dwellings there are no basements. Others are in such bad state that they need complete reconstruction to make them modern. Here is a real business opportunity. Putting in a new concrete basement in an old house means just as much profit as a job involving new construction throughout. Home owners are quick to appreciate the increased value and greater comforts resulting in a home with a modern basement.

There are countless other opportunities for the concrete builder to keep busy the year ’round. Winter work means winter profits for the builder who develops this business. Idle equipment is a liability; active equipment is an asset.

Concrete for Permanence

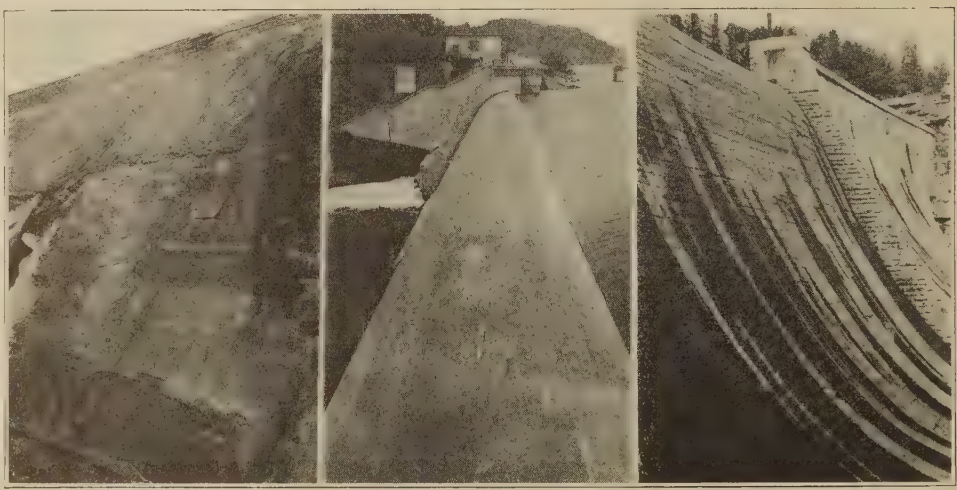
Complete Incorporation of Aggregate in the Paste

The Five Requirements for Durable Concrete. (Summarized from Installment No. 1 in the June issue):

1. Durable, impervious aggregates.
2. A watertight binding medium—the hardened cement-water paste.
3. A mixture that permits complete incorporation of the aggregates in the paste.
4. Methods of mixing and placing to secure a uniform homogeneous mass.
5. Adequate protection and curing.

(Installment 5)

IN the previous installment, a table was given showing the quantity of water to use with each sack of cement for concrete to meet various requirements and conditions of exposure. Having determined the proportion of water and cement from this table for any given case the next step is to find a combination of fine and coarse aggregate which, when used with cement and water in this proportion, will give a suitable consistency for the given structure.



From left to right, the illustrations show, first, a dam less than 7 years old. The very wet consistency used caused segregation and produced a porous surface which offered little resistance to the elements. This dam will require extensive repairs in the near future.

Dam after 16 years of severe exposure. Note the uniformity of texture, total lack of segregation, and dense surface obtained by using concrete of proper consistency.

Dam after 30 years' severe exposure also in excellent condition but slightly eroded at surface and joints between successive layers.

Importance of Consistency

The consistency to use is all-important where durability is a requirement of the concrete. The end desired is that when the concrete is finally in place, it should be homogeneous and uniform from top to bottom with all the space between the aggregate particles completely filled with the cement paste of the required water ratio. With this requirement fulfilled and the hardening process complete, the concrete will present a uniform resistance to the penetration of moisture and the destructive action of frost.

Two extremes are to be avoided. Both the dry non-plastic mixes, and the overwet sloppy mixes are undesirable. The former are difficult to place properly and unless placed with the greatest care are almost certain to leave some honeycombed spots, which provide a point of attack for weathering agencies. The overwet mixes segregate both in handling and when finally in place, with the result that the structure is not uniform throughout, either in the proportion of aggregate to paste, nor in the ratio of water to cement.

Proper Consistency

The proper consistency to use is an intermediate, or plastic consistency that works readily into place, but without segregation or the accumulation of water at the surface. The proportion of fine to coarse aggregate should be high enough to avoid harshness of the mix, but not too high as this results in a high cement factor. A high cement factor means an unnecessary increase in cost and an increase in volume change with varying moisture content.

Effect of Consistencies

In the accompanying figures are given views of three different pieces of construction which illustrate the effect of different consistencies on the durability of the structure.

Cold Weather Construction

All-Year-Around Operation Proves Successful—Winter Work Pays—Specifications for Making, Placing and Curing Concrete in Cold Weather

WHETHER winter weather is ever really too cold to permit building operations and all types of construction work probably has aroused more discussion than any other question ever encountered in the construction field.

There was a time when the building industry quit cold when the first snow flurries were noticed. As a result, aborers lost their jobs, expensive equipment depreciated n idleness, overhead costs piled up, the buying capacity of millions was cut down—and every aspect of business suffered. Needed improvements remained unfinished, costly land produced only bills for taxes; in short, the construction world stood still, waiting for the arrival of spring. And when spring finally came, there was a great rush for labor, materials and everything else connected with the building industry.

Winter Is An Asset

However, winter is now recognized as an asset, not as a liability. Modern builders and equipment scorn the so-called "difficulties" of winter work; modern workers are efficient in cold weather and their jobs reflect that efficiency. The precautions that must be taken are simple and the matter of extra cost is practically negligible, for this is overbalanced by the profits involved. When construction work of all kinds is carried on throughout the entire year and ceases to be a seasonal proposition, capital gains, labor gains and communities profit. Today, the sane common sense of business has ironed out the folly of the winter slump.

ADVANTAGES OF WINTER CONSTRUCTION

Earlier Returns on Investments—The winter months need not hold up progress of the job. Earlier occupancy is obtained.

Reduces Labor Difficulties—Efficient and skilled workmen frequently are more easily obtained in winter.

Construction Costs Are Reduced—All-year-around use of machinery and equipment reduces the charges for overhead and consequently lowers the cost of construction.

Increased Profits for Contractors — Cold weather construction swells the yearly total of a contractor's work.

Lower Costs to the Owner—Contractors like to keep organizations intact during the winter months and consequently sometimes lower their margin of profit on many winter jobs.

Winter work is not new or untried. Millions of dollars' worth of concrete construction is done each winter. In fact, some contractors even prefer winter to summer concrete work. Their reasons for this are that labor, both skilled and unskilled, and construction materials usually are plentiful during the "slack months." Likewise, by keeping his organization busy and his equipment and construction forces in action throughout the year, the contractor's overhead expense is reduced. The extra cost for protection and heat is largely, if not all, compensated for by these advantages. Although the extra equipment for cold weather concreting is very simple, *no cold weather work should be attempted without it.*

Rules for Cold Weather Work

Whenever work is started at such a season of the year that cold weather may be expected before completion of the job, provision should be made to quickly obtain and install enclosing and heating equipment. Adequate protection of concrete against damage by frost during the making and early curing period is absolutely essential whenever temperatures below 40 deg. F. are likely to occur within that period. To obtain reasonable assurance of an undamaged and completely satisfactory job, the following specifications for making, placing and curing concrete in cold weather should be observed.

Protection—When Required

When placing concrete at or below a temperature of 40 deg. F. or whenever it appears probable that the temperature will fall below this limit within 24 hours after placing the concrete, the mixing water and aggregates shall be heated and the freshly placed concrete protected against freezing by adequate housing or covering and heating.

Equipment

The contractor shall have on the job ready to install, adequate equipment for heating the materials and the freshly placed concrete and for enclosing the work in accordance with the requirements for making, placing and curing concrete in cold weather.

Tarpaulins of canvas are the most convenient housing material to use. Mass concrete work such as footings can be covered with canvas or heavy paper covered with about a foot of hay or straw. A simple method of heating aggregates is to heap them over a section of smokestack, steel floor form or metal culvert in which a fire is kindled. The materials are turned occasionally so that all will be heated uniformly and to make sure that all frost and ice are thawed out. Another common type of heater is made by building sides and back of concrete building units with a sheet metal cover on which the aggregates are piled. When facilities for providing live steam are available, aggregates can be heated by placing a perforated 1-inch pipe into the pile and blowing steam through it. A tarpaulin thrown over the pile will help prevent loss of heat.

Mixing water is commonly heated in a large kettle, wash boiler or similar metal container supported over a fire. A few concrete building units will provide a convenient support. Water also may be heated by discharging live steam into it.

Coke-burning salamanders or stoves are used to provide heat on the inside of buildings during concreting and while the concrete is curing. As has been stated, the outside of the work is covered with tarpaulins to keep the heat in.

Temperature of the Concrete

Concrete when placed in the forms should have a temperature of not less than 70 deg. F. nor more than 140 deg. F. Freshly laid concrete and the surrounding air should be maintained at a temperature of 50 deg. F. or greater for a period of 5 days after placing. The methods of protection and curing should be such as to prevent evaporation of moisture from the concrete and injury to the surface.

Tarpaulins protect the concrete and keep the heat from salamanders within the enclosure. Such protection is necessary in cold weather construction

Housing

Before concreting any section of a structure the section should be completely housed or enclosed in a manner that will insure the maintenance of the specified temperatures. The housing should be left in place for the curing period except that sections may be temporarily removed to accommodate placing of other forms or concrete, provided they are replaced immediately after the forms or concrete are in position.

In placing floor slabs, tarpaulins supported on horses or other framework should follow closely the placing of the concrete. Accompanying illustrations show how concrete floors are protected either by tarpaulins or straw. Only a few feet of the finished slab shall be exposed to the outside atmosphere at any one time.

A common method of heating mortar, sand and aggregates in cold weather

Methods of Heating

Within enclosures, such means of artificial heat should be provided as will maintain uniform temperatures meeting the foregoing requirements given under the heading, "Temperature of the Concrete." The contractor should provide adequate fire protection where heating is in progress. Heating appliances such as salamanders should not be placed in such a manner as to endanger formwork or centering or expose any area of concrete to drying out or other injury due to excessive temperatures.

A concrete foundation and floor protected against freezing. Note how layers of straw are held in place. The straw usually is placed over building paper

Either aggregates or water, or both as may be necessary, should be heated with steam coils or other devices, so that the average temperature of the concrete as it is deposited in a form shall fall within the limits specified previously. Aggregates containing frozen lumps should be independently heated and no materials containing frozen lumps, ice or snow shall be allowed to enter the mixer.

Anti-Freeze Compounds and Accelerators

Admixtures intended to accelerate the hardening of the concrete or to produce higher than normal strengths at early periods are helpful when used in percentages which will not have an injurious effect on the normal qualities of concrete.

Preparation of Forms

Before placing concrete in any form or on any surface, or around reinforcement, heat should be applied in such a manner that ice or snow will be completely removed. No concrete should be placed on a subgrade that is frozen or on one that contains frozen materials.

A fire is kindled in this improvised tunnel and the aggregates heaped over it to remove frost

Removal of Forms

Forms should remain undisturbed until the concrete has attained sufficient strength to sustain its own weight in addition to any temporary or permanent load that may be placed upon it during the building of the structure. Beam sides, column forms or forms for walls may be removed as soon as the concrete has attained sufficient strength to sustain its own weight provided that such action does not endanger any part of the structure.

A concrete floor covered with tarpaulins to prevent the concrete from freezing. In extreme cold weather heat should be circulated under such covering

One day prior to the proposed removal of any form or centering, complete inspection of the structure should be made to determine whether or not it is safe to remove forms and supports.

Complete "Cold Weather" Specifications

Complete specifications for making, placing and curing concrete in cold weather and supplementary information on cold weather protection for reinforced concrete work may be obtained by writing to this magazine and asking for a leaflet, "Specifications for Making, Placing and Curing Concrete in Cold Weather."

Winter Construction Work Pays

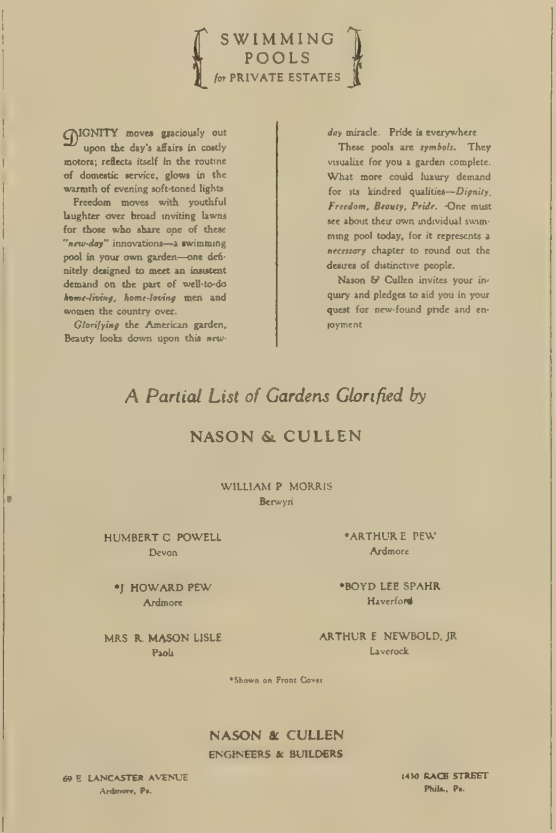
Contractors who carefully do one or two concrete jobs during cold weather will have no fear of undertaking more, and will then have a definite basis for estimating costs of such work. Experienced builders state that the slight additional cost of winter construction work, if any, is more than offset by the saving in general overhead.

While custom may encourage builders and contractors to discontinue construction work in winter, reason tells them that the greatest success lies in continuous operation throughout the year. The so-called difficulties of winter construction are really small when compared to the manifest advantages of all-year-around building activity.

Nason and Cullen Glorify the American Garden

"Glorifying the American Garden," the title of the attractive circular illustrated here, is one of two things that Nason & Cullen, concrete builders of Philadelphia and Ardmore, Pennsylvania, are doing. The other is the development of new work for the company; new concrete construction.

This piece of printed salesmanship is used to stimulate interest in concrete swimming pools. Nason & Cullen have had considerable experience in building this type of concrete structure, as is indicated by the facts presented in the circular. Now, they are "cashing in" on this valuable experience.



SWIMMING
POOLS
for PRIVATE ESTATES

DIGNITY moves graciously out upon the day's affairs in costly motors; reflects itself in the routine of domestic service, glows in the warmth of evening soft-toned lights

Freedom moves with youthful laughter over broad inviting lawns for those who share one of these *"new-day"* innovations—a swimming pool in your own garden—one definitely designed to meet an insistent demand on the part of well-to-do *home-living, home-loving* men and women the country over.

Glorifying the American garden, Beauty looks down upon this *new-day* miracle. Pride is everywhere

These pools are *symbols.* They visualize for you a garden complete. What more could luxury demand for its kindred qualities—*Dignity, Freedom, Beauty, Pride.* One must see about their own individual swimming pool today, for it represents a *necessary* chapter to round out the desires of distinctive people.

Nason & Cullen invites your inquiry and pledges to aid you in your quest for new-found pride and enjoyment

A Partial List of Gardens Glorified by

NASON & CULLEN

WILLIAM P MORRIS
Berwyn

HUMBERT C POWELL
Devon

*ARTHUR E PEW
Ardmore

*J HOWARD PEW
Ardmore

*BOYD LEE SPAHR
Haverford

MRS R. MASON LISLE
Paoli

ARTHUR E NEWBOLD, JR
Laverock

*Shown on Front Cover

NASON & CULLEN
ENGINEERS & BUILDERS

69 E LANCASTER AVENUE
Ardmore, Pa.

1430 RACE STREET
Phila., Pa.

Modern Stucco and Plaster

A Discussion of Standard Practice in Application of Portland Cement Stucco and Plaster

Application and Curing of Portland Cement Stucco

(Installment III)

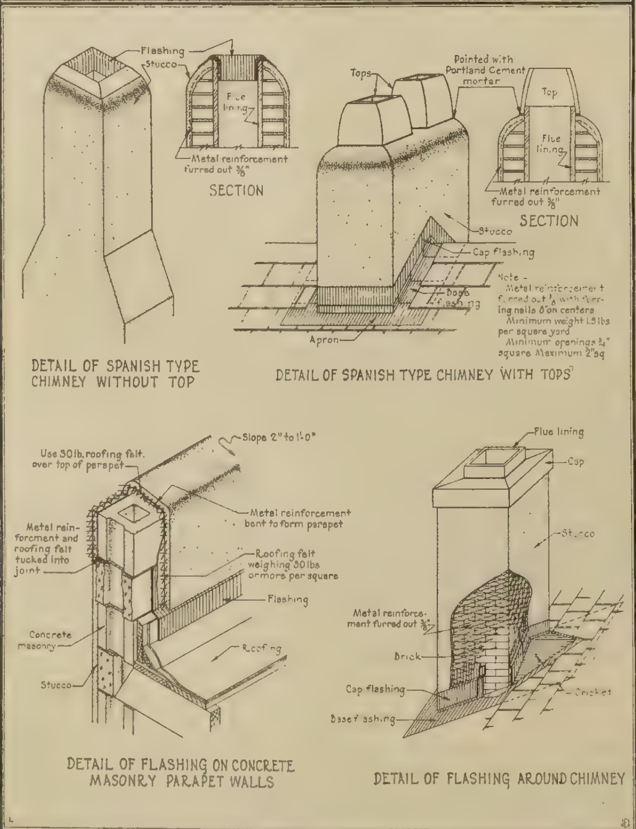
IN the previous articles of this series, stucco materials, proper proportioning and mixing, and suitable bases for portland cement stucco were discussed. Proper application and curing, however, are just as important as correct materials, proper mixing and suitable bases in obtaining a first-class stucco job, and these are discussed herein to include plastering fundamentals as well as fundamentals of construction.

This section is devoted to suction, flashing and the recommended methods of applying the scratch coat, the second or "brown" coat and the finish coat.

Suction

Suction is one of the most important factors governing the application of portland cement stucco. Every plasterer knows what suction is. He also knows how difficult it is to describe exactly the degree of suction required for different conditions. There is a certain "feel" that tells him when suction is right. Suction is absolutely necessary where stucco is to be applied directly to masonry or monolithic concrete bases in order to get the proper bond. It is also necessary in the first and second coats so that succeeding coats will be properly bonded.

FLASHING DETAILS CHIMNEY AND ROOF



DETAIL OF SPANISH TYPE CHIMNEY WITHOUT TOP

DETAIL OF SPANISH TYPE CHIMNEY WITH TOPS

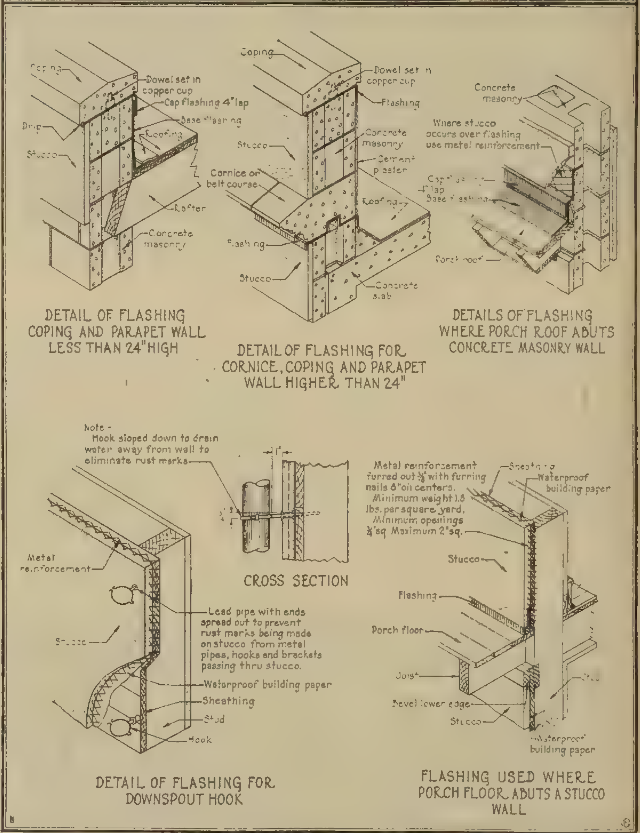
DETAIL OF FLASHING ON CONCRETE MASONRY PARAPET WALLS

DETAIL OF FLASHING AROUND CHIMNEY

Flashing
Stucco
Flue lining
Metal reinforcement furred out ⅜"
SECTION
Tops
Pointed with Portland Cement mortar
Top
Flue lining
Metal reinforcement furred out ⅜"
SECTION
Stucco
Cap flashing
Base flashing
Apron
Note - Metal reinforcement furred out ⅜ with furring nails 8"on centers Minimum weight 1.5 lbs per square yard Minimum openings ¾" square Maximum 2"sq
Slope 2" to 1'-0"
Use 30 lb. roofing felt. over top of parapet
Metal reinforcement bent to form parapet
Metal reinforcement and roofing felt tucked into joint
Roofing felt weighing 30 lbs or more per square
Flashing
Concrete masonry
Roofing
Stucco
Flue lining
Cap
Stucco
Metal reinforcement furred out ⅜"
Brick
Cap flashing
Cricket
Base flashing

Uniform suction is essential in order to obtain uniform color. If one part of the wall draws more moisture from the freshly applied stucco than another, the finish coat may have a spotted appearance.

MISCELLANEOUS FLASHING DETAILS



DETAIL OF FLASHING COPING AND PARAPET WALL LESS THAN 24" HIGH

DETAIL OF FLASHING FOR CORNICE, COPING AND PARAPET WALL HIGHER THAN 24"

DETAILS OF FLASHING WHERE PORCH ROOF ABUTS CONCRETE MASONRY WALL

DETAIL OF FLASHING FOR DOWNSPOUT HOOK

FLASHING USED WHERE PORCH FLOOR ABUTS A STUCCO WALL

Coping
Dowel set in copper cup
Cap flashing 4" lap
Base flashing
Drip
Roofing
Stucco
Rafter
Concrete masonry
Coping
Dowel set in copper cup
Flashing
Concrete masonry
Cement plaster
Stucco
Cornice or belt course
Roofing
Flashing
Stucco
Concrete slab
Concrete masonry
Where stucco occurs over flashing use metal reinforcement
Cap flashing 4" lap
Base flashing
Porch roof
Note - Hook sloped down to drain water away from wall to eliminate rust marks
1"
CROSS SECTION
Metal reinforcement
Stucco
Lead pipe with ends spread out to prevent rust marks being made on stucco from metal pipes, hooks and brackets passing thru stucco.
Waterproof building paper
Sheathing
Stud
Hook
Metal reinforcement furred out ⅜" with furring nails 8" on centers. Minimum weight 1.8 lbs. per square yard. Minimum openings ¾"sq Maximum 2"sq.
Sheathing
Waterproof building paper
Stucco
Flashing
Porch floor
Joist
Bevel lower edge
Stucco
Waterproof building paper

Uniform suction is obtained by dampening, but not soaking, the wall evenly before applying the stucco. If the surface becomes dry in spots, these areas should be dampened again to restore uniform suction. A fog spray is recommended for this work.

Plasterers should work on the shady side of buildings when possible, as it is difficult to keep walls dampened properly when exposed to the sun. Suction is controlled more easily in the shade.

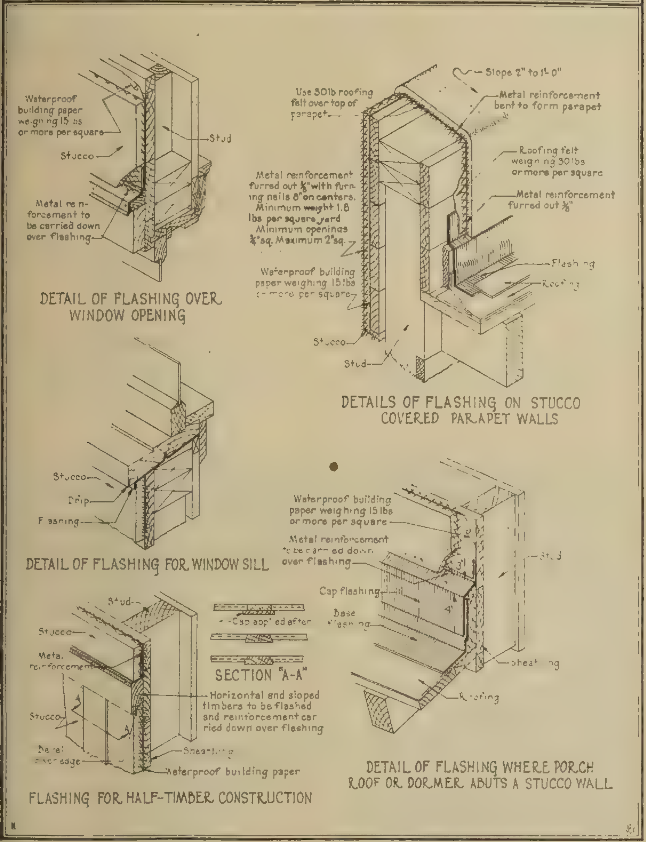
Flashing

Flashing, which is vital to permanent construction, must be so designed and placed that water will not get behind the stucco. Continuous flashing should be placed under all copings, cornices, belt courses and multiple-piece sills to prevent entry of water. Flashing must be a high-grade rust-resisting material. It is folly to use a short-lived metal with so permanent a wall covering as portland cement stucco. Accompanying drawings show flashing details for various types of construction.

The Scratch Coat

The scratch coat should be approximately ⅜-inch thick and carried the full length of the wall or to natural breaking points like doors or windows. Before the scratch coat hardens it should be deeply cross-scratched to provide mechanical key for the brown coat.

Masonry walls on which stucco is to be applied directly should be clean and dry, but before applying the scratch coat the surface must be dampened evenly to control suction, an essential practice in obtaining first-class work. The scratch coat should be troweled on hard and tight, being forced into surface depressions to obtain a permanent bond.


FLASHING FOR STUCCO ON WOOD FRAME

DETAIL OF FLASHING OVER WINDOW OPENING

DETAILS OF FLASHING ON STUCCO COVERED PARAPET WALLS

DETAIL OF FLASHING FOR WINDOW SILL

FLASHING FOR HALF-TIMBER CONSTRUCTION

DETAIL OF FLASHING WHERE PORCH ROOF OR DORMER ABUTS A STUCCO WALL

Waterproof building paper weighing 15 lbs or more per square
Stud
Stucco
Metal reinforcement to be carried down over flashing
Slope 2" to 1'-0"
Use 30lb roofing felt over top of parapet
Metal reinforcement bent to form parapet
Roofing felt weighing 30 lbs or more per square
Metal reinforcement furred out ⅜" with furring nails 8" on centers. Minimum weight 1.8 lbs per square yard Minimum openings ¼"sq. Maximum 2"sq.
Metal reinforcement furred out ⅜"
Flashing
Roofing
Waterproof building paper weighing 15 lbs or more per square
Stucco
Stud
Stucco
Drip
Flashing
Waterproof building paper weighing 15 lbs or more per square
Metal reinforcement to be carried down over flashing
Stud
3"
Cap flashing
4"
Base flashing
Sheathing
Roofing
Stud
Stucco
Metal reinforcement
Stucco
Bevel drip edge
A
A
Cap applied after
SECTION "A-A"
Horizontal and sloped timbers to be flashed and reinforcement carried down over flashing
Sheathing
Waterproof building paper

On monolithic walls, the first coat should be dashed on unless the surface is sufficiently rough to insure adequate bond for the scratch coat when applied with a trowel. Rough surfaces that permit successful application with the trowel are produced by mechanical roughening or through the use of special compounds employed during construction. Surfaces treated by acid-washing generally are not rough enough to retain a troweled scratch coat, in which case a dash coat is necessary. Dashing on the first coat aids in securing intimate bond by excluding air which might otherwise be trapped behind the stucco.

The dash coat is applied using a strong whipping motion at right angles to the face of the wall, or it may be applied with a stucco machine or cement gun. In either case it must be projected with considerable force. The mortar should be of a mushy consistency and composed of 1 part portland cement to 1½ parts of aggregate.

The first coat should be kept damp for at least two days immediately following its application. It should then be allowed to become thoroughly dry.

On metal reinforcement, mortar should completely embed the metal. This is easily accomplished with the large-mesh type of reinforcement, openings being large enough to permit scratch coat mortar to pass through readily. In back-plastered construction using metal lath or wire lath, complete coverage for the metal is assured by the back-plaster coat. This is a ⅜-in. coat of mortar applied to the back of the lath after the scratch coat has hardened sufficiently so that pressure will not break the plaster keys.

The Second or "Brown" Coat

Before starting to apply the brown coat, the surface of the scratch coat should be dampened evenly as previously described under the discussion of suction. The brown coat is approximately ⅜ in. thick. It should be brought to a true, even surface and then roughened with a wood float to provide bond for the finish coat. The brown coat must be damp-cured for at least two days and then allowed to become dry.

The Finish Coat

Before starting to apply the finish coat, the brown coat should be dampened evenly as described under "Suction." Whenever possible, textures should be applied from top to bottom in one operation to eliminate joining marks.

If the finish coat is a factory-made material, manufacturers' directions for application should be followed closely.

To develop maximum strength and density in any portland cement product it is necessary to cure it properly. This is especially true of portland cement stucco, which is really a thin slab of concrete. *Each coat should be kept damp continuously for at least two days.* Moistening should commence as soon as the stucco has hardened sufficiently not to be injured, applying the water in a fine fog spray. Avoid soaking the wall. Give it only as much water as will be readily absorbed. To prevent excessive evaporation on the sunny or windward sides of buildings in hot, dry weather, tarpaulins should be hung over the outside of the stucco and kept moist.

A fog spray is recommended for applying moisture to the wall

After the damp-curing period, each stucco coat should be allowed to dry thoroughly before the next coat is applied. The practice of doubling coats without a two-day moist-curing period followed by a drying interval is not good construction practice.

When stucco is applied during cold weather, longer curing periods are necessary. In freezing weather it should not be applied unless special methods are employed to keep the materials at a temperature above 50 degrees Fahrenheit for at least 48 hours.

Refinishing Old Stucco Jobs

Plasterers may be required to resurface old stucco jobs in order to renew the finish and change the color or texture, or both. This may be done provided the old stucco is in a sound condition. If the original stucco is unsound, it will be necessary to remove the old material entirely and apply a new three-coat job. Where old stucco is not readily removable, as is often the case on masonry backing, it will be necessary to cover the old surface with paper and metal reinforcement and then apply the standard three coats.

Old stucco surfaces when sound are prepared for refinishing as follows:

The entire area is wetted and then cleaned down with a solution of 1 part muriatic acid and 6 parts water. After acid-treating, it should be washed thoroughly with water to remove all traces of the acid and any loose particles.

The wall should be allowed to dry thoroughly and then moistened just prior to application of the new coat to secure uniform suction. On surfaces of coarse or rough texture (as, for example, rough cast work), the new finish may be a single coat applied with the trowel. If the old surface lacks roughness it will be necessary to apply two coats—the first coat being a dash coat to establish bond. After the dash coat has been properly cured, the finish coat is troweled on.

Portland cement stucco must not be applied directly over lime, gypsum or magnesite stucco. These materials either should be removed entirely or they should be covered first with waterproof paper and metal reinforcement as described in Installment 2. In either case standard three-coat portland cement stucco should be applied.

Causes for Discoloration

The most common causes for discoloration are:

1. Failure to have uniform suction in either of the base coats. Improper flashing, and corrosion of flashing or metal attachments.
2. Insufficient mixing of finish coat materials and the use of inferior pigments.
3. Changes in materials or in proportions during progress of a job.
4. Variations in amount of mixing water.
5. Failure to provide drips and washes on sills and projecting trim.
6. Use of additional water to retemper mortar that has partially set up.

Installment IV, which will appear in the November issue, deals with "Typical Portland Cement Stucco Textures" and describes the plastering and texturing tools most commonly used.

Simple Formula for Securing Satisfactory Concrete Surface

A wholly satisfactory concrete surface is rare, more so when one considers the numberless concrete structures and buildings visible. The method described here will result in a surface pleasing to the eye and since it will be permanent and will not discolor, it will never be a source of dissatisfaction or expense for renewal and will always reflect to the credit of the contractor.

The surfaces to be finished are to be rubbed by carborundum blocks, using water in the usual way. After the rubbed surface is dry, dust off the resulting mortar flour with an old rug or burlap.

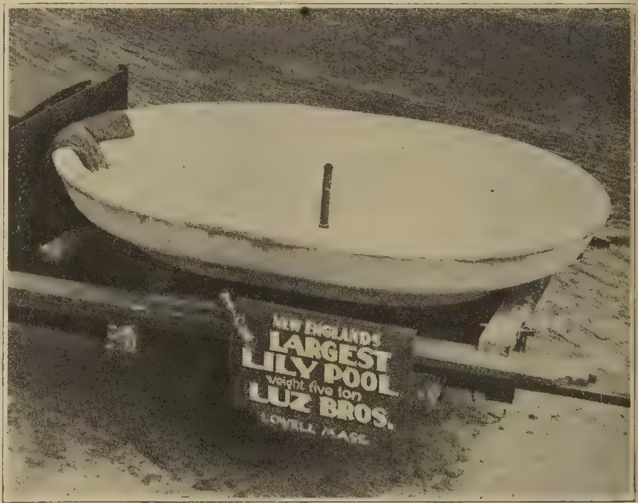
The paste remaining on the surface after rubbing will remain inert *as long as drying* and may be dusted off. Beware of using an old cement bag with fresh cement flying about and entering the surface; if the paste from the rubbing does not dry at once, from following rains, or very damp weather, it will set and become much like a cement wash and will usually discolor; if particles of new cement from a cement bag are dusted on to the surface, the new cement will set with the first dampness and discolor the surface. In effect, the secret involves separating the outer skin of cement from the concrete and removing the inert material entirely, thus exposing the clean homogeneous concrete. When finished in this manner, the surface of the concrete is as unchanging as the concrete mass and as permanent.

If the rubbed surface does dampen again or be wet, it should dry and then be again rubbed in order to secure the desired result.

Gargantua of Lily Pools for Massachusetts Estate

What is said to be the largest precast concrete lily pool in New England and probably in America was recently put in place on a Massachusetts estate. The pool is 13 feet long, 9 feet 8 inches wide and weighs five tons. It was built by Luz Brothers of Lowell, Mass., in their shop and transported to the Daniels estate in Bedford, a distance of approximately 12 miles.

The pool was designed by Andrew Luz. No molds were used, the concrete being shaped entirely by hand around three-quarters of a ton of reinforcing steel. Several unusual features have been incorporated in the design. The pool is so shaped as to resist displacement by ground freezing. The interior is likewise shaped to avoid cracking due to the freezing of any water that might remain in the pool during cold weather.



A shelf circles the interior, affording two water depths to meet the requirements of more varied aquatic life than would be possible at a single depth. The top lip and interior have been finished to the smoothness of velvet. Coarser textures are said to be injurious to the more delicate aquarium fishes.

Moved to its site, the giant pool was hoisted from the truck, set in place on blocks, the ground scooped out from beneath it, and the Gargantua of lily pools lowered into place without cluttering up the estate with heaps of sand, piles of reinforcing and cement and a noisy mixer.

The pool, according to Mr. Luz, cost approximately $500.

Advertising Sells Colored Concrete

Harris Gramm, Inc., Enterprising Concrete Builder of Germantown, Philadelphia, Advertises and Builds Colored Concrete Walks, Drives, Curbs, Terraces—Also Merchandises Other Concrete Work

“LET Gramm do it” is the lead line in one of the advertisements published regularly by Harris ramm, Inc., a concrete contractor at Germantown, Philaelphia, Pa. Those four words eliminate a lot of trouble r architects and builders. For they know when they ive Harris Gramm the job it'll be done right and on time. o worry . . . no delay. And in these very same words arry Gramm tells his prospective customers, through e medium of newspaper advertising, just that.

Concrete—*in colors!*

Modernize! Use colored concrete. Why have colorless walks, drives, curbs, terraces when you can easily and economically make them harmonize with the rest of your home. Ask us about colors and cost. Call GERmantown 60-60.

***HARRIS GRAMM** INC.*

176 EAST TULPEHOCKEN ST.

GERmantown 60-60

apitalize on Demand for Color

In recent months the company has taken advantage of e modern trend toward color in concrete. One of the dvertisements reproduced here urges builders to mod-nize, to use colored concrete in walks, drives, curbs and rraces. As a result of this type of advertising and aggressive personal selling, a large volume of colored concrete work has been developed.

“Let Gramm do it”

On concrete and cement work, those four words eliminate a lot of trouble for architects and builders. For they know when they give Harris Gramm the job it'll be done right and on time. No worry....no delay. Just call GERmantown 60-60.

***HARRIS GRAMM** INC.*

Cement and Concrete

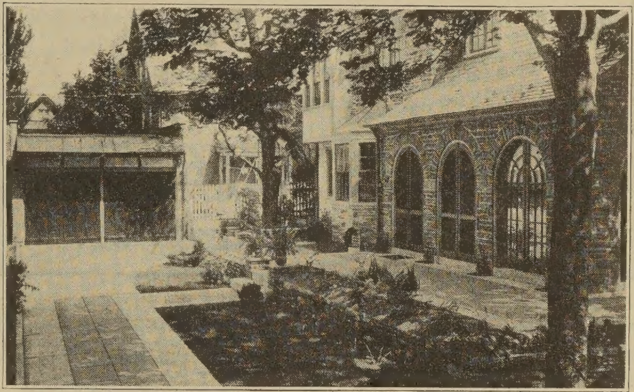
176 EAST TULPEHOCKEN ST.

GERmantown 60-60

Another caption carried on a Harris Gramm advertisement states: “When you pave, pave well!” In developing this thought with the prospect, the following appeal is made to the public:

“Your wife's Easter wardrobe is a perennial expense, but new spring clothes for home and grounds mean one low cost and no repeat bills in after years. Walks, drives, steps, curbs of Gramm concrete are virtually everlasting. Call GERmantown 60-60 now!”

When the prospect calls GERmantown 60-60 and, incidentally, one recent advertisement brought 60 'phone calls, the aggressive salesmanship begins. The prospect not only receives a personal call from a salesman but in addition has the opportunity of inspecting high quality colored or regular concrete work already done by the Gramm workmen.



The driveway, terrace, walk and porch of green concrete enclosed by a natural color border, as shown in this view of his own residence, exemplify Harris Gramm's ideas of color in concrete

Initial Advertising in 1927

Mr. Gramm started advertising in 1927 to educate the public in the advantages of quality construction. At that time, he looked on the plan as a gamble with no way of predicting the exact returns in dollars. However, he firmly believed that advertising is not an overnight proposition and made plans for an advertising program to cover a period of five years.

People expect service and quality from advertised goods. Advertising brings in some large jobs and countless small ones, and each must receive the same prompt, courteous service. Mr. Gramm took these things into consideration.

Harris Gramm advertising in Philadelphia newspapers brings inquiries from home owners all over the eastern portion of Pennsylvania. Each inquiry is answered personally. Where it is impossible for his firm to do the job, the prospect's attention is called to the value of selecting a responsible contractor to do the work. When possible Mr. Gramm refers the prospect to a responsible contractor in the city from which the inquiry is received. It is needless to say that each inquiry received from the territory in which the Gramm organization does business is followed by a personal call—the work done in Philadelphia alone shows that.

Mr. Gramm has an important message for concrete contractors when he states, "Service and quality work are the life of advertising and unless both are present in every job advertising will not bring success.

"The purpose of advertising is to increase business without increasing overhead. Jobs can be obtained which will fill in the slumps and keep both men and equipment busy throughout the season. In winter there is a large amount of inside work which can be done as well in cold weather as in warm. The stories in the advertising should be timely, for these is no advantage in advertising concrete swimming pools in December." An example of the timely advertising of Harris Gramm is the "ad" featuring colored concrete work.

Architects! Builders!

having trouble with
concrete and cement work?

Call GERmantown 60-60

the job will be done
as it should be done by

HARRIS GRAMM INC.

176 EAST TULPEHOCKEN ST.

Formula for Profitable Advertising

According to Mr. Gramm, "Advertising is a business commodity which must be purchased intelligently. The campaign should be a long, even pull and not a flash in the pan that drains the bank account and produces no result except a cloud of smoke. Advertising in the concrete field brings in a highly competitive business and the contractor must not discount the value of a good bookkeeping system that gives him accurate costs on each job. To be profitable, each job must be bid above cost—this means every job—and the only way to know that you will not take a loss is to know your costs.

"Any concrete contracting business will grow if you give the public quality work, at a fair price, and so long as you give the public the service which your advertising has educated them to expect."

Mr. Gramm has found the concrete business a profitable undertaking. And he has also found that advertising and doing colored concrete work have increased his volume of business.

Suburbs and Small Towns Credited with Maintaining Building Volume

Numerous reports for limited periods, or from restricted areas, have appeared in recent months indicating a decline in building operations. With totals for the six months now in hand, there seems to be nothing to substantiate the idea that building has declined, or is declining, according to a survey made by the Central Trust Company of Illinois, Chicago. It is true that permits issued in the principal cities for the first half of this year were 2 per cent below last year, and perhaps 3 per cent below the year before, but, as an offset to this small decline within the corporate limits of the large cities, there is an almost phenomenal growth in many of the smaller cities, and in the suburban areas.

These activities may not be measured as accurately as large city building operations but the movement of building materials by rail supports the idea that there has, as yet, been no material decline in actual construction. Some further restriction in building in the largest cities of the East may occur later in the year but the total delivery of building materials into consumption in 1929 is not likely to be less than in 1928.

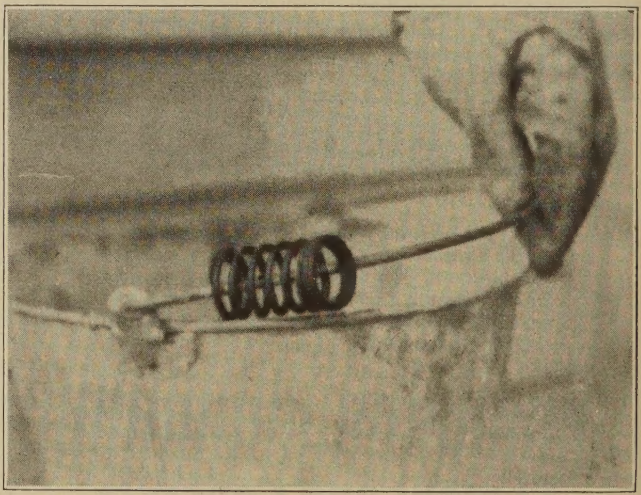
Potential Jobs

In every community there are many houses that are far removed from the present standards of architecture, construction and convenience. In fact, authorities estimate that there are approximately 12,000,000 such old houses which can be profitably modernized. When this is done they are worthwhile *old* homes made *new*. One of these residences may be yours to make more desirable and comfortable for its occupants.

A home is, indeed, an investment which from the practical measurements of dollars and cents must not be allowed to deteriorate. Evidence of this is seen in the fact that home owners everywhere are finding it profitable to modernize their old properties. And because remodeling means always a greater resale value, it may even be considered as a form of insurance which the householder should carry to protect his family in event of any contingency that may force the sale of the house.

Handy "Kink" for Pail Handle

The handle of the average pail used around the mixer always drops down even with or below the rim, where it is often difficult to take hold of to slip the hand under, particularly with gloves on and they often are wet or slippery. Take an old gas engine valve spring and push one of the coil ends over the handle, working half the spring on as shown. It will fit and cling to the handle very snugly, and when forced down near one of the lugs will keep the handle raised a trifle, just enough for the fingers to easily grip and raise it. Does not in any way interfere with the use of the pail.



Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth St., New York City.

American Road Builders' Association; Miss E. A. Birchland, Secretary, 29 W. Thirty-ninth St., New York City.
Twenty-seventh annual convention and road show, January 11th to 18th, 1930. Atlantic City, New Jersey.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Cast Stone Institute; Frank M. Brooks, Secretary, Pasadena, Calif.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Iowa Concrete Products Association; R. L. Gavin, Secretary-Treasurer, 1002 Hubbell Bldg., Des Moines, Iowa.

National Association of Builders' Exchanges; Earl F. Stokes, Secretary, 15 E. Fayette St., Baltimore, Md.

National Concrete Products Association; A. G. Swanson, Secretary, Omaha, Nebr.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Lime Association; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N.W., Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Building, Cleveland, Ohio.

Northwest Concrete Products Association; W. P. Hews, Yakima, Wash.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 3115 Plankinton Arcade. Milwaukee, Wisconsin.

The Concrete Industry
—25 YEARS AGO

UNDER the title, "Biggest Piece of Cement," the October, 1904, issue of CONCRETE quotes the New York press to the effect that "The concrete work being put in by the engineers engaged on the new union station here for the Pennsylvania and the Baltimore and Ohio is said to be the most extensive use of cement ever attempted in the United States.

"The amount of concrete which will be used in the building alone, aside from the approaches, is enormous. It will amount to about 1,000,000 cu. ft."

While it is granted that that was a sizable job in 1904, could early concretors have conceived the 2,000,000 yds. that were poured in a subway project described recently in CONCRETE?

* * *

AN article on "Reinforced Concrete Ties" tells of several experiments made with these units by middle western railroads and another points out the advantages of concrete fence posts, saying, "The manufacture of concrete fence posts is one of the coming industries of the United States."

* * *

IN the fall of 1904 the city of Topeka, Kansas, was reported to be wrestling with the problem of a new building ordinance. "In this connection," CONCRETE stated, "the 'Journal' of that city suggests that the question of whether concrete will withstand fire seems to be pretty conclusively settled by experience in the Baltimore fire and quotes in substantiation extended extracts from a paper read by Perez M. Stewart, an eastern fire authority, before the International Association of Fire Engineers at Chattanooga. Mr. Stewart states in this paper that experience gained at the Baltimore fire shows that concrete is the strongest resistant as a building material against both fire and water."

* * *

A GOOD part of the October, 1904, issue of *Cement Age* is occupied by a report on the "Collective Portland Cement Exhibit and Model Testing Laboratory at the Association of American Portland Cement Manufacturers, at the St. Louis World's Fair." This is followed by an article by A. Considere, on "Concrete and Concrete Steel in France." Regarding mixing water, the latter says: "Some have advised the use of very wet concrete in moulds and forms perforated with holes through which the excess water can be drained; but several experiments have shown that the concrete thus made is greatly inferior as to its resistance and co-efficient of elasticity."

* * *

IN this October issue appears for the first time the department known as "Briquettes," comprised of notes on the progress of the cement manufacturing industry in France, Belgium, Germany and England.

* * *

"CONCRETE street paving is one of the great possibilities of the near future" (one-quarter century ago) "Bellefontaine, Ohio, and a number of other cities, have tested the idea with very satisfactory results." And how many more since?

With the Manufacturers

INDUSTRIAL LITERATURE

Featherweight Roof Slabs

The initial presentation of *Featherweight Concrete insulating roof slabs* by the *Federal Cement Tile Company,* Chicago, is made in a 36-page booklet recently published. Its contents include the story of the roof slabs, detail drawings, specifications and essential data, weights, dimensions, etc., and detail drawings of Featherweight nailing concrete roof slabs.

Ready-Mixed Concrete

"Concrete Facts" is the title of a 16-page booklet giving a brief outline of present practices in mixing and transporting concrete. It is one of the most recent publications of *Transit Mixers, Inc.,* San Francisco, Calif.

Two Color Leaflets

Two new folders on cement and stucco colors have just been issued by the *Blue Ridge Talc Company, Inc.,* Henry, Va. One, entitled *"Color Costs and Information,"* contains tables and data of value in using cement colors. The other, entitled *"Information and Formula Charts,"* includes other information of real value.

Lockstrip Replaces Scoring

Following its development of the *T. M. C. Lockstrip* for cement floors to supplant scoring, form an expansion joint and flush finish surface, the *Lockstrip Manufacturing Corporation,* Long Island, New York, is distributing a new, four-page brochure completely illustrating the installation of the product, in both alternating color cement finishes and one color finishes.

Other leaflets describe T. M. C. Lockstrip Baseground, for plaster, and Lockstrip Curb, for linoleum or rubber tile floors.

Blaw-Knox Publication

The Blaw-Knox Company, Pittsburgh, Pa., has prepared a new booklet, Bulletin 1114, descriptive of Blaw-Knox ready-mixed concrete plants and agitator truck bodies.

It contains numerous illustrations of ready-mixed concrete plants and a description of the complete service rendered by the company in the complete design and construction of equipment for the industry.

Body for Wet Mixed Concrete

To those interested in the subject of centrally mixed concrete, a new loose leaflet describing in some detail the performance and operation of the Wood truck body will prove of interest.

This is *Bulletin* 170, published by the *Wood Hydraulic Hoist and Body Co.,* Detroit, Michigan.

New Universal Publication

"High-Early-Strength Concrete for Roads, Streets and Bridges" is the title of a new 16-page publication prepared by the *Universal Portland Cement Company,* Chicago, containing a number of items of interest. The first of these concerns 50-ft. bridge piles ready to drive in three days.

Concrete Handling Booklet

A new book on wet concrete handling, called *"New Applications and Set-Ups,"* has been compiled by the *Barber-Greene Company* of Aurora, Illinois.

"New Applications and Set-Ups" is a 28-page book, profusely illustrated, covering thoroughly the multiple applications of Barber-Greene belt conveyors on concrete construction jobs.

About Super Cement

"Durable Concrete Construction" is the title of a 24-page booklet descriptive of the properties of Bessemer Super Cement, a product of the *Bessemer Cement Corp.,* Youngstown, Ohio. There are numerous illustrations, followed by references to specifications, trial mix design and several paragraphs on "Impermeability and Permanence."

Aquagel Admixture

A 16-page booklet published by the *Silica Products Company,* Kansas City, Missouri, describes the properties and use of Aquagel admixture in cement, mortar and concrete, its plasticity, its effect on the workability of concrete.

Reference is also made to its value to central mixing plants and in the manufacture of light-weight concrete.

Waterproof Paint Application

Specifications for painting swimming pools, lily ponds, reservoirs and cisterns with *Bondex* waterproof cement paint are given in a small, four-page leaflet prepared by the *Reardon Company,* of St. Louis, Mo.

Another similar folder describes the waterproofing of basements with the same material.

Disintegration Treatise

A brief 2500-word discussion of the factors which cause the disintegration of concrete floors and the results of experiments in the prevention of this type of deterioration has been published by the research laboratory of the *Master Builders Company.*

The author includes charts and graphs to show the extent to which Omicron, a new material, is claimed to render concrete as a whole resistant to disintegration by its chemical combination with calcium hydroxide to form a new substance.

Wire Rope Textbook

What is apparently a complete textbook on the subject of *"Cutting Material Handling Costs"* has been prepared by the *Williamsport Wire Rope Company,* under the names of C. M. Ballard and D. C. Sherman. It covers material transport through aerial ropeways; it compares costs and application and relative advantages with other methods, describes the various types of cableways and tramways, towers and structures; driving and retarding power; location; erection and installation, and mathematical data.

NOTES FROM THE FIELD

Edward Ryerson, Jr., New President

Edward L. Ryerson, Jr., has been elected president of *Joseph T. Ryerson and Son Inc.,* succeeding Joseph T. Ryerson.

The latter will remain a member of the Board and continue to hold the office of treasurer.

C. K. Williams Installs New Services

C. K. Williams and Company, Easton, Pa., have just made announcement of two new service features inaugurated at their Brooklyn, N. Y., location at 70 Kent Avenue.

Customers may now telephone orders and call for goods immediately, or request that they be delivered. The second service feature is the establishment of a one-day trucking service between Easton and New York.

Lewis-Shepard Expands

The Lewis-Shepard Company, Watertown, Mass., has purchased a manufacturing building containing approximately 60,000 sq. ft. of floor space at Crawfordsville, Ind. Production of skid platforms and storage racks was scheduled to begin October 1st.